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A REAFFIRMATION OF THE TAXONOMIC TREATMENT OF *DRYOPTERIS AFFINIS* (DRYOPTERIDACEAE: PTERIDOPHYTA)

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Key words: *Dryopteris affinis,* taxonomy.

As the author who first formulated the treatment of taxa within its species as subspecies, I have often been disappointed that they have been persistently misunderstood in Britain, though successfully recognised in continental Europe. Though difficult to work out during the original research, they are not all that difficult to recognise now and should not have been the subject of so much unnecessary confusion by subsequent authors: the vast bulk of specimens are actually quite easy to identify once one knows the subspecies properly and only a few inadequate ones are dubious, as with any other species-group. I realise though that largely to blame for the problem here is my own failure to publish my finalised treatment of the taxa within *Dryopteris affinis* (Lowe) Fras.-Jenk., even though it is long since written (some five years ago) and a copy of this 300+ page typescript sits in a box at the BM awaiting photographs and minor corrections or additions. The nomenclature and, more importantly, my concepts, have remained stable now for a good number of years and have stood the testing in the field or herbarium that I constantly subject them to. I must admit that mainly due to the "urgent" requirements of certain Floras and projects, a trend to be decried, my published notes on the group have been too brief and hasty, being produced while I was still actively formulating the concepts and nomenclature. As with all new taxonomic research the process of evolution of understanding the group inevitably included several mistakes to start with and, with hindsight as to what others would make of it, should not have been unloaded upon the botanical public at too early a stage, as was required for inclusion in *Hegi's Illustrierte Flora von Mitteleuropa, Greuter's med-Checklist,* the pilot scheme for *Flora Europea* ed. 2 (vis Fraser-Jenkins 1980, 1987 and Dostal, Reichstein and Fraser-Jenkins 1983) or my own work on Spanish *Dryopteris* (Fraser-Jenkins 1982 and see Fraser-Jenkins and Salvo 1984). Some of the changes I had to make subsequent to my original bringing to light of the subspecies resulted from misidentification of poor and difficult type-specimens, such as the erstwhile subsp. *stilluppensis* (Sabr.) Fras.-Jenk., now changed, more satisfactorily, to a new name, subsp. *cambrensis* Fras.-Jenk. (said to be merely "sensu Fraser-Jenkins" by Jermy in Jermy and Camus (1991), which is tautological). Such mistakes are often very hard to avoid when types in a critical group are inadequate and unrepresentative. Otherwise some taxa had to be added to or subtracted from the original subspecies resulting from discovery of new taxa or further understanding of developmental and phenotypic variation within the subspecies. The subspecies subtracted was subsp. *robusta* Oberh. and von Tavel ex Fras.-Jenk. which was soon found by me to be a mere developmental form with long, pointed pinnules and was sunk into subsp. *borreri,* as confirmed also by the competent work of Jessen (1985). But most of my papers were published abroad and did not reach general British botanists and it is sadly ironic that the species is consistently easier to understand in Britain, with its three simple subspecies (and some variants within them which, as I have previously stated, can be ignored), than abroad !

The subsequent problems in the hands of others interested in my work appear to have been three-fold:

1) Certain authors, whose books or papers became widely known in Britain (eg. Page 1982) produced accounts with insufficient consultation and misidentified some of my taxa, eg. Page's illustration of subsp. *affinis* was actually a typical subsp. *borreri,* while, by the time I was made

aware of its forthcoming publication it was too late to make more than a few essential corrections. The account of subsp. *cambrensis* (sub *stilluppensis* at that time) was not properly distinguished from susbp. *affinis* and it was too late to remove "subsp. *robusta*" which I already knew to be a mistake. His collections at Edinburgh herbarium turned out to be widely misidentified, including his three so-called hyrbids (Page 1981) which were large specimens of the subspecies. Perhaps this misidentification explains Dyer's (1996) thinking that "experts" disagree in the naming of specimens.

2) Some other authors (eg. Pigott 1986) departed from and rather ignored the taxa I had carefully studied and catalogued throughout the range of the species and sought instead to invent theoretically possible taxa which neither exist (as far as is known), nor originate from what one actually observes in nature, which is the basis of taxonomic botany. This arose from the fascination of Manton's genome-analysis, particularly as applied by Hugh Corley, who was the first person to understand the genomic constitution of what became my subspecies, nearly 30 years ago. However an excessive and uncalled for "mythological" approach began to spread around latterly, to my disapproval. It only confused the British botanical public into believing that *D. affinis* could consist of an endless array of theoretical taxa, so impossibly difficult to recognise that they rapidly eclipsed the three real subspecies that occur throughout the country. That theoretical systematics could so easily overrun real taxonomy should perhaps have come as no surprise given the example of the North American systematical approach and its influence on Britain. We now suffer from a disastrous lack of "traditional" taxonomic background or knowledge while at the same time over-concentrating on high-profile, high-tech pseudo-taxonomy. Combined, these two problems of approach do not enable techno-protagonists to make meaningful decisions concerning the real situation existing in nature, nor do they allow for natural human abilities or limitations in recognising taxa.

3) The continued hijacking of my treatment of the three subspecies also involved ignoring the ranks I had carefully chosen for them and the less significant variants within them. This ranged on the one hand from a North American attempt (Beitel and Buck 1988) to treat them all as species on the theoretical basis of their being biologically separate, but failing to allow for the vitally necessary balancing of this with "artificial" (ie. practical aspects of separability) considerations in their species-concept, to, on the other, a refusal to recognise the ranks in the proper taxonomic-nomenclatural way at all, thus invalidating the taxa themselves. This latter approach was pioneered by Jermy (in Jermy and Camus 1991) who, even after access to my book and after consultation with me as to the circumscription of one learning to recognise the taxa, ended up causing even further confusion by employing the device of "morphotypes" which had the end result of placing the minor varieties on a par with the major subspecies. They also continued to recognise *robusta*, which I had already sunk. The resulting picture was as clear as mud, despite excellent illustrations and descriptions, as no-one knew any more which were the three entities to look for. It is possible that failure to recognise the taxa played some part in the production of this scheme, but it was largely based on an attempted compromise with my insistence on not treating the three entities as species in their own right on a par with other species in the genus. But it had unfortunate results unforeseen at the time and it is true to say that the situation in Britain now is one where very few people can actually recognise the three subspecies. That I was indeed justified in making them subspecies, as argued again in detail by Fraser-Jenkins (1988, "Subspecies or species ?"), is encouragingly confirmed by the fact that this now turns out to be exactly the middle ground between unsatisfactory extremes, as I had guessed it would, as well as the continued ability of this approach to work in the field in all corners of Europe and western Asia, as I have deliberately set out to see. At the same time, certain, clearly less significant, partly geographical, more-or-less constant forms within the subspecies are treated as varieties whose morphology shows that they belong to the subspecies

concerned. But again the situation in Britain is much simpler than abroad as only three additional varieties seem to occur here and these can easily be ignored if preferred, which I suspect is most likely to be the case.

So what *should* we do about *D. affinis*, as asked by Dyer ? I believe the answer is to treat it exactly as I have done, ie. as updated in my forthcoming book, which is summarised here below. It is not desirable to treat it any differently from any other equivalent fern group and it should be within the framework of the widely used ranks of the *latest International Code of Botanical Nomenclature*, avoiding the unpopular practice of creating "microspecies" as in some flowering-plant genera. There is no place for abdicating taxonomic responsibility and decisions by resorting to "morphotypes". Any treatment should be soundly based on a wide-ranging, carefully executed, "traditional" taxonomic study made throughout the full range of the species, as I did over the last 15 years or more (including detailed work throughout all the relevant herbaria - 195 of them in all, as well as comprehensive follow-up work throughout Europe's mountain ranges), combined with cytological investigation, including 16-celled sporangial meiotic analysis and, when available, drawing on any additional information from chemistry etc. as we have already published. The morphology, cytology (carried out by many workers and all listed in the book after re-identification of 177 voucher specimens cited by me) and chemistry (Widén, Fraser-Jenkins, Reichstein, Gibby and Sarvela 1996) have in fact all come together to give a clear picture of the taxonomy of *D. affinis* in Britain, as consisting of the three major subspecies. These are to be called subsp. *affinis* (diploid, with genomes WO, where W= "ancestral *affinis*", probably, *D. wallichiana* (Spreng.) Hyl., and O=D. *oreades* Fomin, as deduced from its chromosome-pairing behaviour and that in the hybrids *D.* x *complexa* Fras.-Jenk. and *D.* x *asturiensis* Fras-Jenk. and Gibby), subsp. *cambrensis* (triploid, with genomes WOO) and subsp. *borreri* (triploid with genomes WOC, where C = probable *D. caucasica* (A. Br.) Fras.-Jenk. and Corley, as shown from chromosome-pairing behaviour in *D.* x *complexa*), all based on various different but closely related, hybrid-derived combinations of the W and O genomes. These taxa are now well known to various continental botanists such as Boudrie, Badré, Jessen, Nardi, Alejandre Saenz, Orribe Echebarria and many others, including former authorities such as Gätzi and Döpp who knew the taxa well long before they were properly evaluated relatively as to rank.

The distinction between the subspecies of *D. affinis* and the only known British hybrid of it, *D.* x *complexa* Fras.-Jenk. (tetraploid and pentaploid), has also been clearly outlined in my papers and book. The hybrid exists in Britain as two cryptic nothosubspecies (see below) which, again, can be ignored if preferred. As stated in my book, *D.* x *complexa* seldom occurs as more than a few individuals in a population does not appear to spread from locality to locality but to arise *de novo* in each place it occurs, ie. it behaves as a hybrid, not as a species. It can be recognised by its distinctive morphology combined with the great bulk of its spores being abortive (though in artificial culture a low degree of fertility occurs). Dyer's question about hybrids with a high proportion of viable spores is not what exists (or has been published), even though the hybrid does follow Döpp-Mantonian apomictic sporogenesis, nor are tetraploid and pentaploid *D. affinis* known or suspected to exist. I see no need to become lost in a maze of speculation not indicated in nature or by previous research, especially if the author cannot certainly distinguish *D. affinis* from *D. filix-mas* which he raised as a question.

No one has ever suggested that the biological background to the subspecies of *D. affinis* has anything to do with the case in *Thelypteris phegopteris* (L.) Slosson (= *Phegopteris connectilis* (Michx.) Watt) just because they are both apomictic. The two are quite incomparable because *T. phegopteris* is a single entity in Europe derived from a single origin, not continuing three genomically distinct taxa. So why should it be very like *D. affinis* ? This is a simple misunderstanding. Incidentally, as it now turns out, apomicts are not necessarily any more or any less variable than are sexual taxa provided they are of one genomic (not "genotypic") constitution.

I hope to publish my book before long as it contains the necessary comparative, diagnostic descriptions, detailed keys and sketches and it is intended to include clear sets of photographs of each taxon as well. The end result is hoped to be that the subspecies will become widely recognised and well known to British botanists, especially, which would undoubtedly clear up the recent rash of problems. The conspectus of taxa present in mainland Britain is as follows and from a position of experience I strongly advocate that people should adopt it. This scheme is used by Stace (1991), following my publications and the advice I gave during a *D. affinis* workshop and field excursion for the B.S.B.I. some years ago at Leicester University:-

Dryopteris affinis (Lowe) Fras.-Jenk.
subsp. *affinis*
subsp. *cambrensis* Fras.-Jenk.
subsp. *borreri* (Newm.) Fras.-Jenk.

Dryopteris x *complexa* Fras.-Jenk. (= *D. affinis* x *D. filix-mas*)

For those who wish to study geographical variation within the subspecies it can be pointed out that (all names now validated) there are three variants within subsp. *affinis* present in the British floristic region and Ireland, var. *affinis* (the commonest variety), var. *paleaceolobata* (Moore) Fras.-Jenk. (endemic to western Britain) and var. *kerryensis* Fras.-Jenk. (endemic to southern Ireland). There are two variants within subsp. *cambrensis*, var. *paleaceo-crispa* (Moore) Fras.-Jenk. (the commonest variety in Britain, which unfortunately cannot be named with the same epithet as the subspecies under the rules of nomenclature and is largely superceded on the continent by var. *insubria* Oberh. & Travel ex. Fracs.-Jenk.) and var. *pseudo-complexa* Fras.-Jenk. (known only from a few places in west Scotland and Ireland, or on the Continent; somewhat imitating *D.* x *complexa* nothosubsp. *complexa*, but triploid). *D.* x *complexa* contains two nothosubspecies, nothosubsp. *complexa* (subsp. *affinis* x *D. filix-mas*, tetraploid, and the commonest nothosubspecies in Britain) and nothosubsp. *critica* Fras;-Jenk. (subsp. *borreri* x *D. filix-mas* and pentaploid). Previous reports of subsp. *cambrensis* x *D. filix-mas* from Britain were in error, and nothosubsp. *contorta* Fras.-Jenk. is a synonym and lobed form of nothosubsp. *complexa*, following Dr. Gibby's unpublished tetraploid chromosome-count of it for me. It is interesting that the horticultural cultivar 'Pinderi' is an abnormal, narrow form of subsp. *affinis*, while cultivar 'stableri' is a similar form of *D.* x *complexa* (nothosubsp. *complexa*) and actually arose spontaneously from a stray spore of *D. filix-mas* hybridising within a prothallial culture of 'Pinderi'.

Naturally taxonomic research will continue to advance and though I have rejected certain other named taxa (invalidly named, fortunately) put forward by Pigott I accept that there is a small possibility that there could be two taxa within subsp. *borreri*, as he has suggested, perhaps varieties. But if both show the similar low chromosome-pairing pattern in 16-celled sporangia that is characteristic of subsp. *borreri* and both contain the characteristic phloroglucide, para-aspidin, not present in the other subspecies, I would be disinclined to recognise it, especially as intermediates occur, at least on the Continent. The other question, which could be rather unfortunate, is whether subsp. *cambrensis* and subsp. *persica* contain the same genomes; they look distinct enough, but if it could be shown that they were both WOO it could be argued that subsp. *cambrensis* should just be a variety (var. *paleaco-crispa* of Moore) of subsp. *persica*, or at specific rank, for the whim of North American systematists, *D. schorapanensis* Askerov (as unfortunate as the fact that the obscure name, *D. mindshelkensis* Pavlovski, from Tadzhikistan, must now replace the name, *D. submontana* (Fras.-Jenk. and Jermy) Fras.-Jenk., being conspecific !). This question should not cause any reappraisal of subsp. *cambrensis*, as yet, because the two appear quite distinct and are probably rather unlikely to be mere geographical forms of each other. Nevertheless it should be investigated by further hybridisation-progammes and genome-analysis.

To put things in perspective with *D. affinis* it should be realised that the vast bulk of the world's fern-species and complexes, especially in S.E. Asia and central America, have never been investigated by advanced molecular-biological techniques and most probably will never be so. It would be a quite impractical and obstructive philosophy to say that we should not produce a taxonomic treatment until that has been done. It is true that very superficial treatments (as in south Asia and China) are more trouble than they are worth and take much more time to sort out and re-evaluate than to describe spurious new species etc. in the first place. But in this particular case both the biology and "traditional" taxonomy have been very carefully worked out and are well known. Just because an author has not personally got to grips with the group is no reason to reject its treatment, when many others have succeeded. I hope that British Floras will henceforth treat the subspecies clearly following the scheme produced so far, as with any other group. This should be considerably assisted when the full documentation given in my book is published.

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THE RECOGNITION OF *DRYOPTERIS AFFINIS* SUBSPECIES

In the recent *Pteridologist* (Volume 3 part 3, 1996) there were three articles discussing the various authors' problems of identifying the subspecies of *D. affinis*. The preceding article by Christopher Fraser-Jenkins was written in response to these articles.

In the 7th edition of *Welsh Ferns* (currently in press) George Hutchinson and I have followed Fraser-Jenkins in recognising three subspecies, although we have commented that not everyone may accept this treatment.

Fraser-Jenkins has criticised the treatment of this species given by Christopher Page in his 1982 book *The Ferns of Britain and Ireland*. But, as this book is now 14 years old, Page's own views have changed so the inclusion of the following brief statement seems timely.

[Barry A. Thomas; Ed.]

A REPLY TO C.R.FRASER-JENKINS

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The existence of different taxa within *D. affinis* is a topic about which many pteridologists have long been aware, and most (among which I include myself) have always been keen to listen to ideas about progress, in my case from all who had ideas to offer. This is healthy for science, including pteridology, and the way in which science progresses.

I now see how inexactly I delimited the morphology of this apogamous complex and made mistakes in my 1982 *The Ferns of Britain and Ireland*' (completed in 1980, before all but one of the publications cited above by Fraser-Jenkins !). My specimens cited here by Fraser-Jenkins were also collected in the 70's when at least I could see and draw attention to differences in what had hitherto been regarded then as a single species! So I do not think I have to apologise for this because our current ideas may also look outdated in another 15 years time!

There is a new text version, with new illustrations, in *The Ferns of Britain and Ireland* edition 2 (currently in preparation). Christopher Fraser-Jenkins has kindly helped me in the drafts, as have many others. When differing viewpoints have been expressed to me in the intervening decade and a half, I have tried to arrive at the most accepted consensus on every point, and to support these with my own field observations. Nothing is perfect, but I believe that this new account will at least represent the overall situation at the present time. That is the role of my book.

ASPLENIUM x *JACKSONII* REDISCOVERED IN THE WILD (ASPLENIACEAE: PTERIDOPHYTA)

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Key words : *Asplenium jacksonii*, France, hybrid.

ABSTRACT

Asplenium x *jacksonii* (*A. adiantum-nigrum* x *A. scolopendrium*) had not been found in the wild since its first sightings in Great Britain in the 19th century. A new plant of this hybrid, recently discovered in W. France is described. Its morphology basically corresponds to the plants collected in the past and a preliminary cytological investigation suggests that the plant is triploid, with most of its chromosomes unpaired.

INTRODUCTION

Asplenium x *jacksonii* (Alston) Lawalrée is an extremely rare hybrid, resulting from a cross between *Asplenium adiantum-nigrum* L. and *A. scolopendrium* L. It was first discovered in Britain in 1856 almost simultaneously in two localities; in Guernsey (Channel Islands) by C. Jackson and near Hartland (N. Devon) by J. M. Chanter (Lovis & Vida 1969). A few further sightings were also reported in Great Britain in the 19th century, namely in Devon, Cornwall and Jersey. It would seem that no other wild sightings have been recorded since 1872 (Alston 1940; Lovis in Stace 1975; Jermy & al. 1978).

The first plants discovered and kept in the T. Moore (K) herbarium were described by him as *A. adiantum-nigrum* var. *microdon* (Moore 1859)[1]. The assumption of a hybrid origin and then the involvement of the Hart's Tongue fern as one of the parents were envisaged later, but it is not possible to give the precise chronology of the evolution of the concepts as to the plant's status. A satisfactory interpretation was evoked by Stansfield (1924) but it was not before Alston (1940) that a correct taxonomic description was given for this plant under the name of x *Asplenophyllitis jacksonii*[2].

Following the rediscovery in Guernsey in 1965 (Girard & Lovis 1968) of the near-related hybrid *A.* x *microdon* (*A. obovatum* subsp. *lanceolatum* x *A. scolopendrium*), attempts have been made to synthesize experimentally *A.* x *jacksonii* in order to make a comparative cytological study. Artificial hybrids have been obtained but with a very low percentage of success (Lovis & Vida 1969). In comparison and under similar experimental conditions, the crossing which gives *A.* x *microdon* succeeds with a greater ease. This great difficulty in forming hybrids, probably due to the coexistence in *A.* x *jacksonii* of three different genomes, would explain the extremely rare occurrence of the plant in the wild in spite of the frequent coexistence of its parents which are sometimes found in great numbers in our Atlantic regions.

THE REDISCOVERY OF *A. x JACKSONII*

It was with surprise (and emotion) that we spotted, in September 1994, a quite unusual fern plant, indisputably an "*Asplenophyllitis*" a few kilometres from Cap Fréhel (Brittany, France). It was undoubtedly a juvenile plant as it had not been noticed on visits to the area in previous years. Moreover, the gradual increase in the length of its fronds marked the stages of the plant's development. The plant possessed 5 small fronds, most of them already withered, measuring from 6 to 11 cm (only the latter bore a few sori) and 3 larger fronds, quite green and fertile, two of them measuring about 15 cm and the third about 20 cm (stipes included).

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[1] Moore had already described some time earlier the near-related hybrid known today as *A.* x *microdon* (Moore) Lovis & Vida under the names *Asplenium marinum* var. *microdon* and later *A. lanceolatum* var. *microdon*.

[2] Hybrid genus maintained if Hart's Tongue ferns (*Phyllitis*) are considered separate from *Asplenium s.s.* at generic level (Reichstein 1981; Page 1982).

Even if the plant could be said to belong to the "*Asplenophyllitis*" group beyond any doubt, its exact status remained to be established. Considering the triangular outline of the leaf-blades, and also the habitat very rich in *A. adiantum-nigrum*, it could reasonably be suggested that it was *A.* x *jacksonii*. However, cytological confirmation was necessary. The fronds were still bearing young sporangia so a fixation was possible and the analysis (made by H. Rasbach) showed that the plant is triploid (*c.* 108 chromosomes) and presents practically only univalents in meiosis. It could also be observed that some of the chromosomes are larger than others, as shown by Lovis & Vida (1969) in experimentally synthesized hybrids involving *A. scolopendrium*. Therefore, this first cytological analysis proved the plant to be *A.* x *jacksonii*. It confirmed the first sighting of this hybrid in the field for the 20th century, as well as a new addition to the French flora.

Several croziers started to develop in October 1994. These fronds were fully developed in June 1995, on the occasion of a visit to the site by H. & K. Rasbach and R. Viane. These form the basis for the following description.

CHARACTERS OF THE PLANT

The original description of the first specimens of *A.* x *jacksonii* collected in the 19th century by Moore (1859) was later recalled by Lovis & Vida (1969) and Page (1982) who also provided illustrations showing the very particular outline of the fronds of this hybrid. Lovis & Vida also stressed that, apart from some very small individual variations, the hybrids obtained experimentally corresponded perfectly to the plants found in the wild, especially with regard to those characters separating them from the near-related taxon *A.* x *microdon*. Most of these important characters are present in our plant (Fig. 1 & 2).

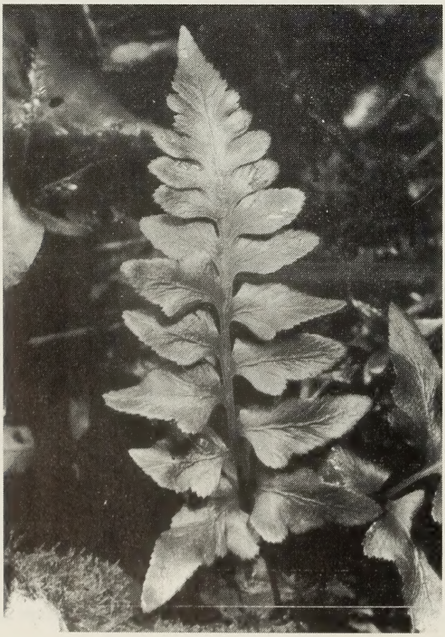

Figure 1. *Asplenium* x *jacksonii* in situ. Photo K. Rasbach, 18. VI. 1995.

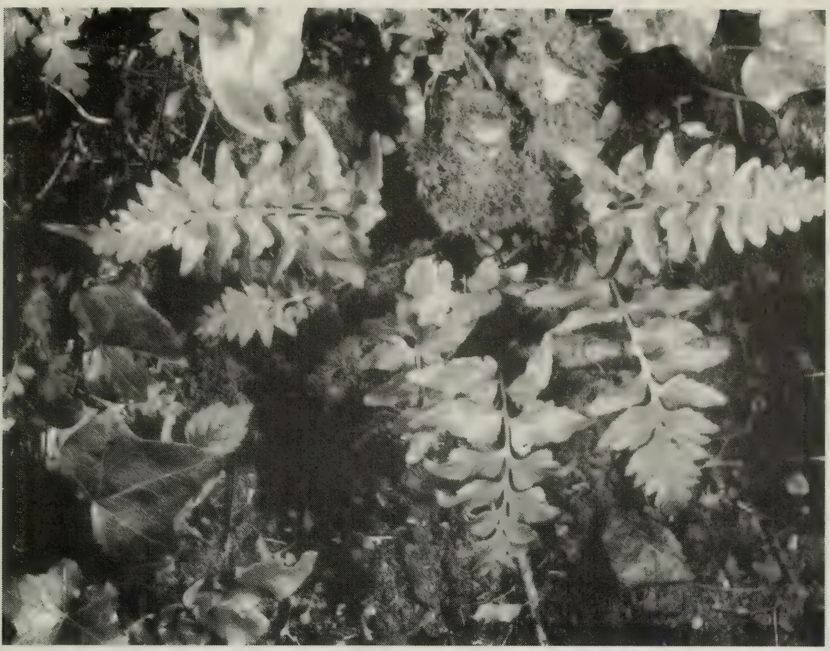

Figure 2. *Asplenium* x *jacksonii* in situ. Photo K. Rasbach, 18. VI. 1995.

The fronds are few (four in 1995), rather erect, 21 to 23 cm long. The stipe is entirely black on the lower side (the black colour continuing along the rachis) and along about three quarters of its length on the upper side ; it measures from 9.5 to 12 cm long, which more or less equals the length of the leaf-blade [in *A.* x *microdon*, the stipe is proportionally much shorter, not exceeding a quarter of the overall length of the frond]. The leaf-blade presents an overall triangular outline, the widest part situated at the level of the lowermost pinnae [in *A.* x *microdon*, the leaf-blade is lanceolate due to a certain reduction in length of the lowermost pinnae]. The pinnae are, on the whole, entire with frequently overlapping margins. The margin is toothed, the blade surface often undulating. Basal lobes on the lower pinnae tend to jut out with the acroscopic lobe being more marked than the basiscopic one, although not entirely separated up to the costa. The upper pinnae are more or less confluent on either side of the rachis giving the upper part of the frond a very distinctive aspect and showing the influence of the *A. scolopendrium* parent [these characters are also present in *A.* x *microdon*]. The sori often attain (or even slightly exceed) 5 mm in length. They are situated near the main vein of the pinnae, which perfectly matches the illustration given by Lovis & Vida (1969 : fig. 21) [in *A.* x *microdon* the sori are shorter, usually 2 to 3 mm, and situated rather near the edge of the pinnae].

On one point, however, the recently discovered specimen differs from the original description of the plant. The fronds which flushed in 1995 only bear asplenioid sori, whereas Moore indicates for his *A. adiantum-nigrum* var. *microdon* that the "sori are ... very frequently scolopendrioid". This character might perhaps vary on future leaves so we propose to monitor this closely.

It should be added that owing to its hybrid origin, the plant only develops very irregular spores of a completely abnormal aspect. On the 1995 fronds, sporangia were mostly aborted in their development and have a shrivelled appearance, something like "dried currants"; a character which is often observed in *Asplenium* hybrids.

THE NEW LOCALITY

It is situated in northern Brittany, in the commune of Fréhel, Département of Côtes d'Armor. The plant grows on the ground, in a sub-coastal wood, under a mixed canopy of common oak (*Quercus robur*) and ash (*Fraxinus excelsior*), with *Pinus pinaster* and *Quercus ilex*. The under canopy is dense in shrubs: *Cornus sanguinea*, *Ligustrum vulgare*, *Acer campestre*, *Crataegus monogyna*, *Corylus avellana*. At field level, *Ruscus aculeatus* is common, accompanied by *Rubia peregrina*, *Melica uniflora*, *Brachypodium sylvaticum*, *Iris foetidissima*, *Tamus communis* and *Hedera helix*. Three ferns are abundantly present: *Polystichum setiferum*, *Asplenium adiantum-nigrum* and *A. scolopendrium*.

This habitat appears rather different from the slightly more artificial lane-banks where *A.* x *microdon* was found in Guernsey and where, apparently, the *A.* x *jacksonii* plants were collected last century. These differences, however, are probably only superficial as strong similarities can be seen. This Brittany locality is sheltered from the wind, it is located in an area where even in the absence of local meteorological statistics the climate appears to be damp and very mild. Moreover the plant does not grow among the shrub proper but on the edge of a small footpath which is a sort of man-made enclave. Here the earth has been disturbed which has certainly helped the formation of the hybrid by permitting a very dense development of prothalli.

Located as it is, the plant is rather vulnerable. However, it was thought more advisable to leave it in place rather than transplant it. A close watch of the locality will be maintained to ensure that the area undergoes no modification detrimental to the survival of this remarkable and unique specimen.

ACKNOWLEDGEMENTS

We wish to express our thanks to H. & K. Rasbach (Glottertal, Germany) for the cytological analysis and the photographs of the plant, to P. Ryan and N. Jee (Guernsey) for leading us to the localities of *A.* x *microdon*, permitting very useful comparisons, and to A. & P. Labatut (Bergerac) for the English translation.

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WILD FERN GAMETOPHYTES WITH TRACHEIDS

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Key words: Gametophyte, tracheids, Madhya Pradesh, India.

ABSTRACT

Although fern gametophytes with tracheids have been recorded under experimental conditions (Demaggio, 1972; Dyer, 1979; Loyal 1982) this is the first reported occurence of them in the wild. Several gametophytes from Madhya Pradesh, Inida have simple annular thickened tracheids.

MATERIAL AND METHOD

Four young green gametophytes, looking superficially like bryophytes (Fig-1A.), were collected in 1993 from rocky grooves near a water fall in Pachmarhi (Madhya Pradesh, India). Observation under a light microscope revealed the presence of tracheids in the mid rib. Collections during 1994 and 1995 yielded about half a dozen further prothalli, of which two possessed tracheids in their mid ribs. Each time, two younger prothalli were fixed in acetic alcohol fixative (1:3) for 12 hrs. and processed for acetic-orecin (1.5%) stained squashing in order to see the mitotic divisions. The larger prothalli were kept in Knop's solution for routine observation. Thoroughly cleaned prothalli were also placed in culture flasks containing MS medium in order to see if tracheids develop in cultures. Ferns growing near the waterfall were also collected and identified.

OBSERVATION AND DISCUSSION

The green dichotomising prothalli (Fig-1A) measured 0.5 to 2.5 cms in length (Fig.-2A). Older prothalli showed a defined mid rib with several outgrowths on the margin (Fig.-1B). They have long globose and capitate stalked hairs, paraphysis-like structures and a few hairs, looking superficially like balloons, that are always found near the stomata (Fig-1B, C, D, E, F). Globose hairs associated with stomata are acually seen all over the dorsal surface of the prothalli (Fig.-1A, 2D). A characteristic feature of these prothalli is the clustering of cells to form thicker regions near the apical notch of each branch (Fig.-2A). Small globose outgrowths arise from the depression while club shaped antheridia, often two in number, arise protrude above the prothallus (Fig.-2B). Young branches of an otherwise old prothallus sometimes exhibit an incipient mid vein which, on squashing, reveal simple tracheids with annular thickenings (Fig.-3). It is intriguing that not all branches of the prothallus, nor even prothalli of the same group, show a distinct mid vein with tracheids. However, repeated collections indicate that the development of tracheids in the mid vein of 5 out of 14 prothalli in the gene pool. Perhaps a major problem in this study was that small branches of the prothallus transferred to knop's solution and culture media could be maintained only for 30 to 40 days. After this time chlorosis started.

Long, single celled rhizoids arise from localised areas of the ventral surface of the prothalli. Antheridia (Fig.-2B) arise on the tips or in notches on mature prothalli. Antheridia at the margins mature early and huge masses of antherozoids were visible. Unfortunately, attempts to count mitotic chromosomes have not been successful as yet.

Soil taken from close to the site of these gametophytes did not reveal any fern spores, but futher attempts will be made in late winter (January).

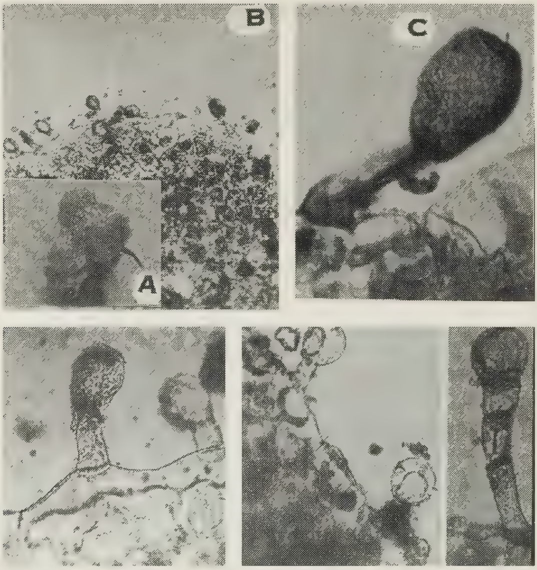

Figure 1. a. A green dichotomously branched gametophyte with a hairy surface, x 4. b. Glycerine mount of the same prothallus showing hair like outgrowths from the peripheral area of the notch. A bifurcating mid rib is also visible (X100). c. Unusual globose outgrowth with an ostiole. The thick tough stalk is surrounded by a thin membranous sheath. Such multicellular structures have always been seen arising adjacent to a stoma (X120). d-f Capitate, globose and multicellular paraphysis like structures arising on the epidermis (X100)

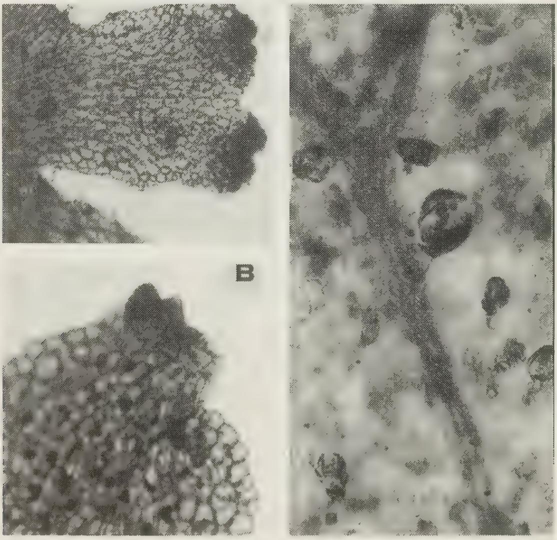

Figure 2. a. A branch of very young prothallus showing clustering of cells (like apical meristems) that include antheridial cells (X25). b. Apical portion of the same prothallus after a week in Knop's solution showing the origin of club-shaped antheridia protruding above the prothallus. The stalk is embedded in the gametophytic tissue (X40). c. Dorsal surface of a mature prothallus showing a mid rib with annular thickened tracheids. Stomata and globose epidermal hairs are visible all over the surface.

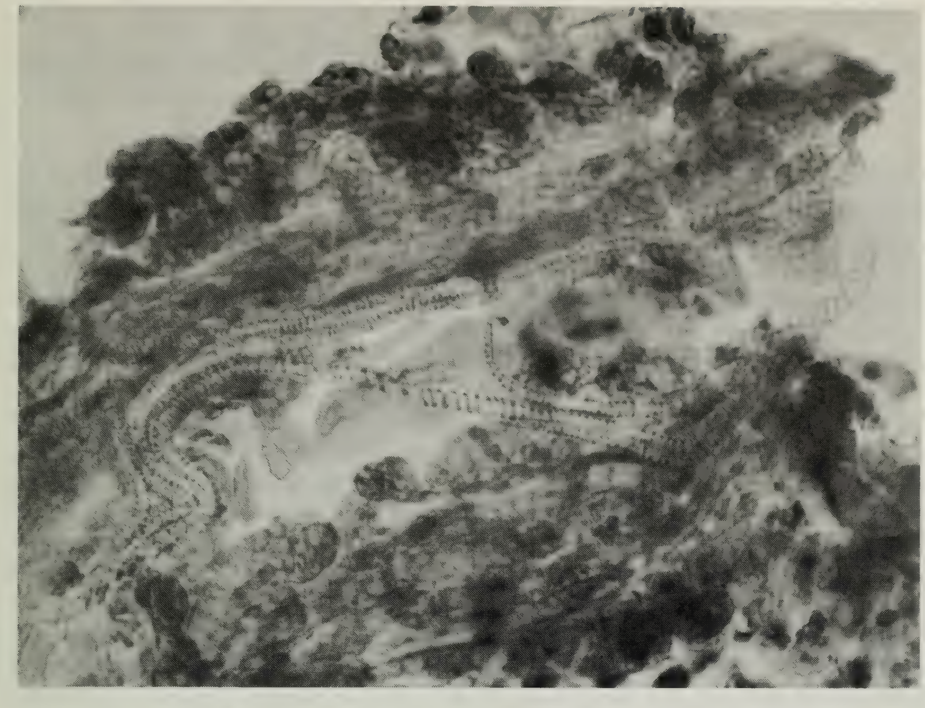

Figure 3. Aceto-orcein stained squash from the apical notch area revealing tracheids with annular thickenings (X400).

DISCUSSION

The presence of tracheids with annular thickening in the mid vein of these wild collected fern gametophytes with antheridia is a feature new to the botanical literature. It is known that xylogenesis can be induced in gametophytes grown in culture (see Dyer, 1979: Demaggio, 1972) but this new record of their presence in naturally occurring prothalli should be of immense interest to pteridologists, morphologists, and plant evolutionists in general.

While we can not identify with certainty the sporophyte of these gametophytes, we can offer a suggestion based on the occurrence of fern genera growing within 3 metres of the prothalli. These are *Asplenium cheilosorum*, *Asplenium* sp (Possibly small sterile plant of *A. normale*) and *Chelianthes anceps.* These species are also known to occur near water-falls in Pachmarhi and recently Vasudeva and Bir (1993) have listed them among the endangered ferns of the area. *Chelianthes* appears most likely to be the sporophyte although epidermal structures found on these gametophytes do not strictly correspond with those of either *Asplenium* or *Chelianthes.*

ACKNOWLEDGEMENTS

I thank Professor Pant and Dr. D. R. Mishra (Allahabad) for help with the references.

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BOOK REVIEW

FARNE UND FARNVERWANDTE. BAU, SYSTEMATIK, BIOLOGIE.

By K.U. Kramer, J.J. Schneller, E. Wollenweber .Thieme Verlag, Stuttgart, 1995,
198 pp. Price 69 DM. ISBN 3-13-115301-6.

FERNS AND FERN ALLIES, MORPHOLOGY, SYSTEMATICS AND BIOLOGY, written by three eminent academic researchers on pteridophytes in central Europe, gives a comprehensive overview on state of the art pteridology, omitting only palaeobotany and physiology. . Nearly all areas of research as well as new developments are presented. It is timely, covering and collating recent and relevant research papers (mainly written in English), and it is very readable. A book such as this was long overdue and it is very welcomed. "Farne und Farnverwandte" has one disadvantage, it is written in German, and therefore deprives a larger worldwide audience of its stimulating contents.

Pteridophytes present very exciting biological questions. These are addressed using many different scientific approaches from anatomy to classification, from morphological comparison to chemotaxonomy, microevolutionary studies using cytology or molecular techniques. The book is divided into eight chapters on the life cycle, morphology, systematics, geography, ecology, biosystematics, chemotaxonomy, pteridophytes and man, and a glossary. Each chapter has an up to date reference list to encourage further reading. The late Professor Kramer (Zürich), one of the world's leading experts on pteridophyte taxonomy, was the mastermind behind this project, contributing the detailed and fascinating accounts of his views on morphology and classification of pteridophytes. Professor Wollenweber (Darmstadt) has written the chapter on chemistry and chemotaxonomy and Professor Schneller (Zürich) the chapters on ecology and biosystematics.

It is difficult to find justifiable criticism without appearing to be too pedantic. However, as the biosystematics of the European *Asplenium* is close to my heart, I would like to make a comment on the choice of *Asplenium adiantum-nigrum* as "the" (illustrated) example for an allotetraploid taxon of known ancestry. This is a myth perpetuated in books and many papers, and has frequently been cited since the original work by the Manton School in Leeds and published in 1969 by both Shivas, and Lovis and Vida. The origin of *Asplenium adiantum-nigrum* as an allotetraploid derived from the diploid *Asplenium cuneifolium* and *Asplenium onopteris* was inferred from cytological evidence. Unfortunately, 95% of cytological data published there and since have been equivocal and thus non-informative. Lovis (1977) already stated that *Asplenium adiantum-nigrum* was of probably segmental allotetraploid origin, and even this cautious statement has now to be verified after the exciting discovery and publication of the cytology of hybrids involving *Asplenium adiantum-nigrum* in Guernsey (Channel Islands) by Cubas & Sleep (1994).

Despite this small faux-pas I can warmly recommend this book and only urge the publisher to consider an English version. There is nothing like it, in English!

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Johannes Vogel

FOUR SUBSPECIES OF THE FERN *BLECHNUM PENNA-MARINA* (BLECHNACEAE : PTERIDOPHYTA).

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Kew words: *Blechnum penna-marina*, Australasia, South America.

ABSTRACT

Four subspecies are recognised within *Blechnum penna-marina*: subsp. *penna-marina*, subsp *alpina*, subsp. *microphyllum* and subsp. *boliviana*. Only subsp. *alpina* occurs in the Australasian region whereas all the subspecies occur in the South American region.

INTRODUCTION

Blechnum penna-marina (Poiret) Kuhn is the Southern Hemisphere equivalent of the boreal *B. spicant* (L.) Wither. in terms of occupying similar ecological niches. Indeed, there are extreme variants of *B. spicant* that may at first sight appear similar to robust *B. penna-marina*. *Blechnum spicant* is circum-boreal from the latitudes of Spain northwards, with the exception of some areas in North America. While there are many forms and variations of *B. spicant*, there are also a few distinctive, related species in the east Asian region: *B. eburneum* Christ (China, Taiwan), *B. amabile* Makimo (Japan), *B. castaneum* Makimo et Nemoto (Japan), *B. nipponicum* (Kunze) Makimo (Japan) and *B. hancockii* Hance (Taiwan, Japan), if distinct from *B. nipponicum*. *Blechnum eburneum* is the most distinctive of this group of species, with the sporangia remaining enclosed by an indusium at maturity. *Blechnum homophyllum* Merino, which has a very restricted distribution in Spain, is almost certainly one of the variant forms of *B. spicant*.

Blechnum penna-marina has a wide distribution in the cooler latitudes of the Southern Hemisphere. It has been recorded as one of the most common ferns south of Concepcion on the west coast of South America, and extends to most of the subantarctic islands. It is found also in temperate mainland eastern Australia, Tasmania and New Zealand. The very robust form, which is given the status of subsp. *boliviana* in this paper, extends northwards in South America to Bolivia, at least to latitude 16°S (Unduavi 16°20'S, 67°55'W) but at high altitudes of up to 3300 m. Further eastwards in Brazil it extends north to at least S. Catharina (21°46'S, 49°W).

Blechnum penna-marina is an extremely plastic species. Under harsh conditions it can reach maturity as very small plants with thick coarse leathery leaves. The widespread distribution of this species, together with its striking variability, are largely responsible for the long list of synonyms attributed to it. Colenso (1846, 1888, 1895) described a range of species for New Zealand but apparently did not describe the typical, reduced alpine form with its small overlapping, sterile, and short, thickened falcate, close-set fertile pinnae.

Within its natural range *B. penna-marina* shows an extremely wide tolerance to altitudinal and climatic variations. When brought into cultivation it shows considerable phenotypic plasticity.

However, extreme ecological forms of the subsp. *alpina*, when brought into cultivation, tend to maintain the characteristics of their growth forms as seen in the field for at least one year. This suggests that there may be some genotypic variation (Chambers 1954) — perhaps races that tolerate alpine screes have been selected to tolerate extreme climatic conditions.

In New Zealand *Blechnum penna-marina* becomes increasingly common south of 37°S. The most northern report of this species in New Zealand is from Kawau Island (Buchanan 1876) although no herbarium specimen is available to support this record. The species has definitely been recorded on the scoria cone of the relatively recently extinct volcano Rangitoto Island (36°47'S) near Auckland and is increasingly common further south, especially in montane and subalpine areas. In the South Island it is a component of many communities from sea-level to near the upper limit for the growth of vascular plants. It is commonly found in *Nothofagus* forests, subalpine grasslands, shrublands, herb fields and even on alpine screes.

Blechnum penna-marina has never been found on the African mainland, although it has been recorded from, and is often common on, most of the subantarctic islands. The species has been recorded from Madagascar: there are three sheets in Univ. Botaniske Museum Copenhagen, only one of which Morton (1961) reports as being adequately labelled: "'*Polypodium. Commerson,* Madagascar ded. Dr. Thouin, Hb. Vahlii', i.e. collected by Philibert Commerson in Madagascar, and presented by André Thouin of Muséum d'Histoire Naturelle, Paris, to Martin Vahl, Professor of Botany, University of Copenhagen, probably some time around the year 1800". The two other collections are also labelled Madagascar but only one has collector's initials and these are illegible. If these records are correct, then the species is probably now extinct in Madagascar. However, Morton points out that *B. penna-marina* was not reported from Madagascar by Christensen (1932) nor by Tardieu-Blot (1960), and it seems more likely that the three collections are confused specimens.

It is noteworthy that Reginald Kaye in his book *Hardy Ferns* (1968) recognised two entities: *Lomaria alpina* (p. 182) and *Blechnum penna-marina* (p. 168-9). However, his application of these names does not coincide with the nomenclature used in the present paper.

MATERIALS AND METHODS

All spores examined in this study were from herbarium specimens. Spores were mounted on double-sided sticky tape on stubs, coated with gold in a sputter coater and examined under a scanning electron microscope (SEM). Measurements were taken from electron micrographs and so may differ slightly from measurements taken from fresh material (e.g. those of Large & Braggins 1991) because of shrinkage and immaturity of spores (more difficult to assess for herbarium specimens). Measurements of spores from different specimens and different collections were used in calculating average spore size.

RESULTS

Blechnum penna-marina (Poiret) Kuhn

Polypodium penna-marina Poir., in Lam., *Encycl.* 5: 520 (1804); *Lomaria penna-marina* (Poir.) Trevisan, *Atti Ist. Veneto Sci.*, 570 (1868); *Blechnum penna-marina* (Poir. in Lam.) Kuhn, *Filic. Afr.* 92 (1868); *Struthiopteris penna-marina* (Poir.) Maxon & Morton, *Bull. Torrey Bot. Cl.* 66: 44 (1939), T: Straits of Magellan, *Commerson*; holo: P; iso: FI, BM.

Lomaria antarctica Carm., *Trans. Linn. Soc. Lond.* 12: 513 (1818), T: Tristan da Cunha; holo: BM.

L. polypodioides Gaud. ex Desv., *Ann. Sci. Nat. (Paris)* 5: 98 (1825) [non *Blechnum polypodioides* Raddi, *Syn. fil. bras.*, 16 (1819)], T: I. Soledad, Arch. des Malouines, [Falklands] *d'Urville*; holo: P (Morton photo at BM seen, no. 4389); iso: FI.

These names were based on *L. polypodioides* Desv. ex Gaud: *B. latiuscula* Bory, ined., d'Urville (P) [top right hand specimen only]; *B. penna-marina* var. *latiuscula* (Bory) Morton; *Stegania alpina* R. Br. var. b. *latiuscula* Bory in d'Urville, *Mém. Soc. Linn. Paris*, 4: 597 (1826).

We have not seen type specimens for the following names, but from their descriptions they can most probably be referred to *B. penna-marina* subsp. *penna-marina* (rather than to subsp. *alpina*): *Acrostichum polypodioides (polytrichoides* in error in text*)* A. du Petit-Thouars, *Esquisse fl. Tristan d'Acugna* (1804), reprinted in *Mélang. bot.*, 32, pl. II (1911), T: Tristan da Cunha; *B. alpinum* var. *elongata* Mett., *Fil. lechl.* 2: 15 (1856-59), T: "Peruvia: Agapata in uliginosis, Chili, ex *Philippi* l.c."; *Lomaria uliginosa* Phil., *Linnaea* 29: 105 (1857), *Blechnum* *uliginosum* (Phil.) C. Chr., *Index filic.* 160 (1905), T: Chile, "In peninsulae *Tres Montes* paludosis, loco S. Rafael, dicto invenit cl. Dr Fonk"; *Blechnum parvulum* Philippi, *Anales Univ. Chile* 580 (1873), T: Juan Fernandez Puerto de Ingles; *Lomaria uliginosa* Phil. var. *magellanica* Phil., *Anal. Univ. Chile* 93: 353 (1896), T: "In Freto Magellanico Decembri 1877 lecta."

Lomaria trichomanoides Desv., *Mém. Soc. Linn. Paris.* 6(3): 287 (1827) [no locality was given and the plates were never published] may be referable to either subsp. *penna-marina* or subsp. *alpina*; the description is inadequate to place it with certainty.

Rhizome short- to long-creeping or suberect, scaly; scales broadly ovate, somewhat bullate, entire, pale brown to reddish brown, relatively large in comparison with the size of the plant, to 2-4 x 1-2 mm, thin, papery. *Fronds* dimorphic, 4-73 cm long and 0.6-3.4 cm wide, fertile fronds usually longer and more erect than sterile. *Stipes* 0.5-31 cm, reddish brown to purplish black, darker towards the base and sometimes becoming stramineous above, scaly especially at base, scales similar to those of the rhizome, linear to ovate, somewhat bullate, entire, reddish brown. *Lamina* linear-lanceolate or lanceolate, pinnatisect to pinnate, 4-64 pairs pinnae. *Rhachis and costae* stramineous or reddish brown below, becoming stramineous towards apex, small sparse scales especially on lower surface, acuminate, entire, brown to reddish brown, c. 1-2 x 0.5-1 mm. *Sterile pinnae* oblong to somewhat triangular, obtuse to acuminate or minutely mucronate, 3.5-18 mm long and 2-6.5 mm wide, papery to coriaceous, adnate, close or overlapping at rhachis, margins entire to crenate, basal pinnae gradually becoming shorter, rounder and more widely spaced, sometimes reduced to very narrow flanges. *Fertile pinnae* narrower, more widely spaced, linear and somewhat falcate, obtuse, sori covering undersurface except sometimes basal few pairs of pinnae sterile, indusium broad, brown, laciniate. *Spores* monolete, bilaterally symmetrical, perine scabrate to microvermiculate, microrugulate or microverrucate, exine smooth to granulate or scabrate.

There are four subspecies.

KEY TO THE SUBSPECIES

1. Plants small, not more than 28 cm tall; sterile pinnae constricted close to the rhachis and usually distinctly crenate ....subsp. *microphyllum*

1* Plants larger, up to 73 cm tall; pinnae adnate to the rhachis with broad bases, entire or very slightly crenate 2

2. Plants large and robust, fronds up to 73 cm tall and 3 cm wide ....subsp. *boliviana*

2* Plants not as large, fronds up to 40 cm tall and 2.7 cm wide....................................3

3. Stipe dark purplish black, dark colour of stipe usually extending into rhachis; pinnae 6-19 x 3-6 mm and tending to be imbricate; living plants rich dark green .... subsp. *penna-marina*

3* Stipe dark reddish brown at base, usually becoming stramineous below rhachis; pinnae 3.5-13 x 2-6 mm and only tending to be imbricate when growing under harsh exposed conditions; living plants glaucous green to rich green, often with a characteristic sheen especially in exposed localities ....subsp. *alpina*

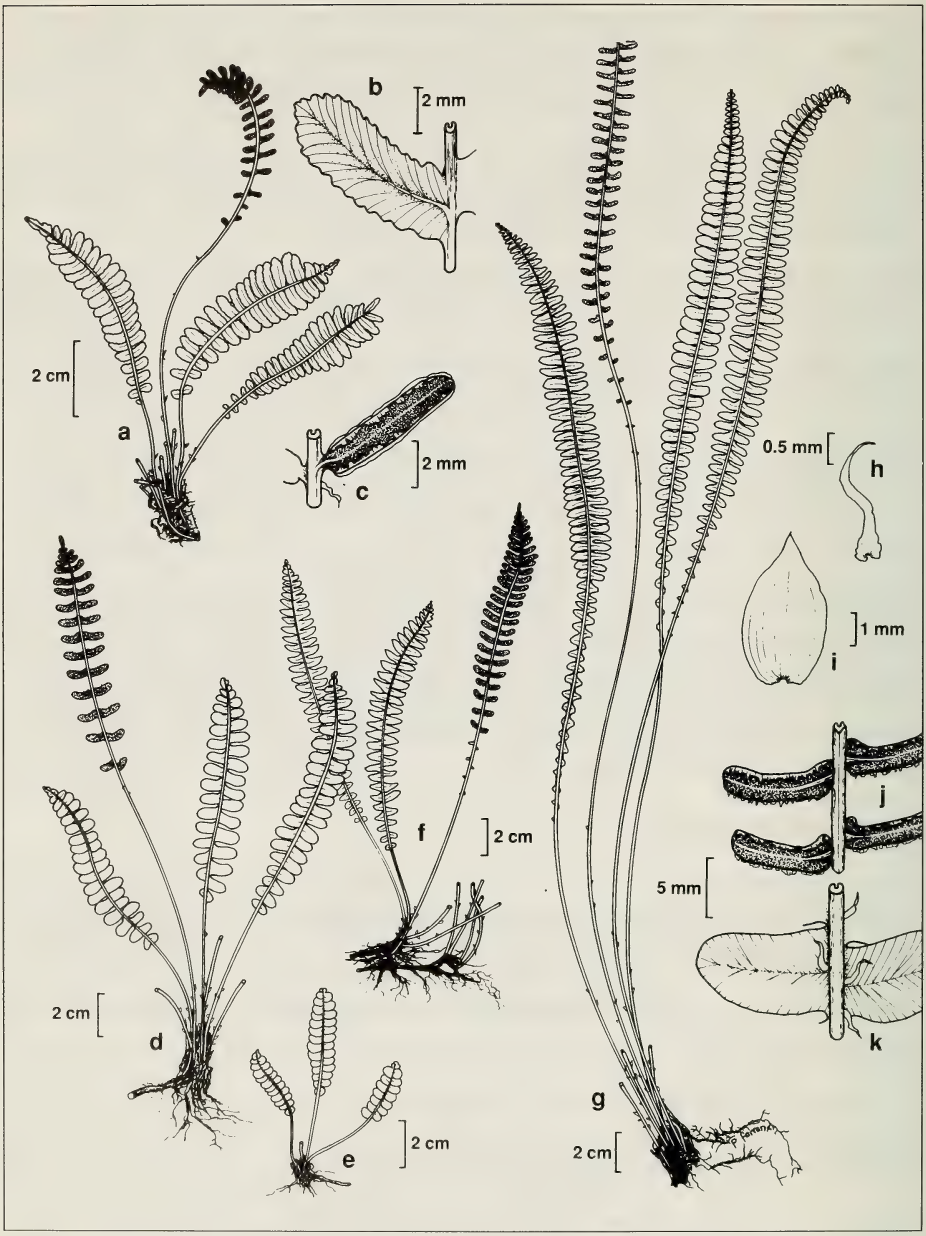

Figure 1 a-c *Blechnum penna-marina* subsp. *microphyllum*: **a.** Habit, **b.** Underside sterile pinna. **c.** Underside fertile pinna (NSW 235310, Chile). **d-e.** Subsp. *penna-marina*: **d.** Habit (composite illustration drawn from NSW 235309, Chile, NSW 235304, Brazil, and from photos of material from Tristan da Cunha). **e.** Habit (NSW 235306, Tristan da Cunha). **f.** Subsp. *alpina*: habit (NSW 236002, NSW Australia). **g-k.** Subsp. *boliviana*: **g.** Habit. **h.** Scale from rhachis. **i.** Scale from base of stipe. **j.** Underside fertile pinna. **k.** Underside sterile pinna, scale same as j (NSW 235305, Bolivia).

Blechnum penna-marina (Poir. in Lam.) Kuhn subsp. ***penna-marina***

Rhizome short or long creeping, slender. *Fronds* 4-40 cm long and 0.6-2.7 cm wide, living plants rich dark green. *Stipes* 0.5-20 cm, dark purplish black, dark colour of stipe usually extending into rhachis. *Lamina* linear-lanceolate, pinnatisect-pinnate, 4-40 or more pairs pinnae. *Sterile pinnae* oblong-obtuse or somewhat triangular, 6.0-19.0 mm long and 3-6 mm wide, papery to coriaceous, adnate with broad bases, margins entire or slightly crenate, often reflexed.

Spores 37.5 x 28.3µm (n = 4 specimens, spores viewed with SEM), perine scabrate to microvermiculate, exine smooth, granulate or scabrate.

Illustrations: **Figure 1d-e**; Hooker, pl. 32 (1859) [as *Lomaria alpina* Spr.]; du Petit-Thouars, pl. II (1911) [as *Acrostichum polytrichoides* in text and *A. polypodioides* in plate].

Cytology: 2n = 66: Manton & Vida (1968) for material from Tristan da Cunha. Progeny raised at Kew from spores of a wild gathering from the Falkland Islands proved similar.

Distribution and habitat: This subspecies occurs in South America (from southern Brazil through southern Chile to Cape Horn) and in the Falkland Islands, Tristan da Cunha, Gough I., Marion I., Kerguelen I., St. Paul I. and Amsterdam I. It occurs in various conditions, from very humid, to cool temperate, to hot humid tropical (where it is usually a little etiolated).

Selected specimens:
FALKLAND ISLANDS: Roy Cove, West Falkland Islands, *E. Vallentin*, 1909-11 (K); Port William, East Falkland Is, *Lechler 84* (K).
TRISTAN DA CUNHA: Tristan da Cunha, *R.A. Dyer 3521* (K); above Burnwood, 600-700 m, *Y. Mejland 640* (K); Nightingale Island, *M.S. Stableford 13*, 1953-54 (K).
KERGUELEN ISLAND: Royal Sound, Kerguelen Is, *A.E. Eaton* Feb 1875 (E, K); *Moseley s.n.*, Jan 1874 (E); Fullers Harbour, *W. Thomson of H.M.S. Challenger*, 1874 (E); *Crosbie s.n.*, 1874 (E); Ile Australie, Port du Ketch, *P. Cour 253* (P).
BRAZIL: Southern Brazil, *s. coll.* (NSW 235304).
CHILE: Rio de las Miñas, Punta Arenas, *G. Rumbelsperger*, Dec 1882, Herb. Schwacke 4452 (P, RB); Vaqueria de Chreni, Valdivia, *Philippi*, 1877 (P) [as *L. uliginosa*]; Chile, *Philippi s.n.* (BM) [as *L. uliginosa*].
STRAITS OF MAGELLAN & TIERRA DEL FUEGO: Port Famine, *Lyell s.n.*, Sept. 1851 (E); Tierra del Fuego, *C. Darwin 407*, 1833 (K, mixed sheet); Orange Harbour, Fuegia, *Wilkes US South Pacific Expl. Exped.* 1838-42 (K).
MARION ISLAND: Nellies humps inland of Transvaal Cave, *B.J. Auntley 2071* (K).
AMSTERDAM ISLAND: *G. de l'Isle 48* (K).
GOUGH ISLAND: *R.N. Brown s.n.*, Nov. 1904 (K).
CROZET ISLANDS: Piton du Camp, 100 m, *Reneau 14* (P).

Notes: Herbarium material of this subspecies is difficult to separate from pressed material of subsp. *alpina*. However, subsp. *penna-marina* is distinct in cultivation: material from Tristan da Cunha, for example, is larger and coarser than material from New Zealand, with wider overlapping pinnae (but not on all fronds) tending to be imbricate in their insertion; it is a much richer dark green (whereas subsp. *alpina* is glaucous green to rich green with a characteristic sheen, especially in exposed localities). The stipes of subsp. *penna-marina* are dark purplish black and tend to be thicker than in subsp. *alpina*, and the dark colour usually extends upwards to the base of the rhachis; in subsp. *alpina* the stipes vary from dark to reddish brown, often losing this colour before the rhachis zone.

Material here defined as *B. penna-marina* subsp. *penna-marina* collected from the subantarctic island of Tristan da Cunha and material here defined as *B. penna-marina* subsp.

alpina collected from New Zealand, cultivated for some years by the late Professor Irene Manton at the University of Leeds, were compared in 1970. The growth forms of the two subspecies are illustrated in Figure 2 and clearly show the differences in sterile frond and pinnae size and form. Cytologically the Tristan da Cunha material was 2n = 66 and the New Zealand material 2n = 68, a figure also reported by Brownlie (1954) for New Zealand subsp. *alpina* material. However, some populations of subspecies *alpina* are 2n = 66 (Quinn 1961).

Blechnum penna-marina (Poiret) Kuhn subsp. ***alpina*** (R. Brown)
T.C. Chambers & P.A. Farrant

Stegania alpina R. Br. *Prodr.* 152 (1810); *Lomaria alpina* (R. Br.) Spreng., *Syst. veg.* IV, 62 (1827); *Blechnum alpinum* (R. Br.) Mett., *Fil. hort. bot. Lips.*, 64 (1856), T: lat Mont Tabul., Derwent, Tasmania, *R. Brown 44*, 1802-1805; lecto (here chosen): BM; isolecto: BM.

L. pumila Raoul, *Ann. Sci. Nat. Bot. Ser. 3*, 2: 145, t2A (1844), T: “Akaroa in muscosis”; holo: probably B, *n.v.*; iso: K.

L. linearis Colenso, *Tasmanian J. Nat. Sci.* II, 176 (1846), T: near Te Waiiti [Te Whaiti] SE from Rotorua, *Colenso*, Jan 1842; holo: WELT.

L. parvifolia Col., *Trans. & Proc. New Zealand Inst.*, 20: 224 (1888), T: “High slopes of Tongariro Mountain Range, County of East Taupo; 1887; per Mr. H. Hill”; holo: K; iso: AK.

L. distans Col., *Trans. N.Z. Instit.*, 27: 615 (1895) [non *Blechnum distans* Presl]; *Blechnum hillii* C. Chr., *Index filic.* 155 (1905), T: “Ruahine Mountain-range, east side: Mr. H. Hill; 1894”; holo: K.

Illustrations: **Figure 1f**; Crookes & Dobbie (1963) p. 275; Jones & Clemesha (1981) fig. 98, p. 101; Duncan & Isaac (1986) fig. 20.13, p. 212; Brownsey & Smith-Dodsworth (1989) fig. 189, p. 148, pl. 33F [all as *Blechnum penna-marina*].

Rhizome short or long creeping, slender. *Fronds* 4-40 cm long and 0.6-2.7 cm wide, glaucous green to rich green, often with a characteristic sheen especially in exposed localities. *Stipes* 0.5-20 cm, dark reddish brown at base, usually becoming stramineous before rhachis. *Lamina* linear-lanceolate, pinnatisect-pinnate, 4-40 or more pairs pinnae. *Sterile pinnae* oblong-obtuse to somewhat triangular, 3.5-13 mm long and 2-6 mm wide, papery to coriaceous, adnate with broad bases, margins entire or slightly crenate, often reflexed. *Spores* 32.4 x 24.0 µm (n = 8 specimens, spores viewed with SEM) for Australian material, 32.2 x 23.5 µm (n = 10 specimens, spores viewed under SEM) for New Zealand and Macquarie Island material, perine scabrate to microvermiculate or microverrucate, exine smooth, granulate or scabrate.

Cytology: 2n = 68 for New Zealand (Brownlie 1954) or 2n = 66 for New Zealand South Island, North Island and Campbell Island material (Chambers 1954), 2n = 66 for Tasmanian material (Quinn 1961).

Common names: Alpine hard-fern, Little hard-fern, Narrow hard-fern

Distribution and habitat: In New Zealand and many sub-Antarctic islands (North Island, South Island, Stewart Island, Chatham Islands, Auckland Islands, Campbell Island, Antipodes Islands), eastern Australia, Macquarie Island and South America. Occurs from lowland to montane habitats, in open grassland, alpine herbfields and screes and scrub.

Selected specimens:

NEW ZEALAND: North Island: Mt Pihanga, Tongariro National Park, 3700’, *K. Wood*, Apr 1952 (NSW 235318); Waimiha River, near Pureora, central North Island, 1700’, *R.O. Gardner* 1839, Mar 1978 (NSW 235330). South Island: Cobb River Valley at foot of Mt Peel, Golden

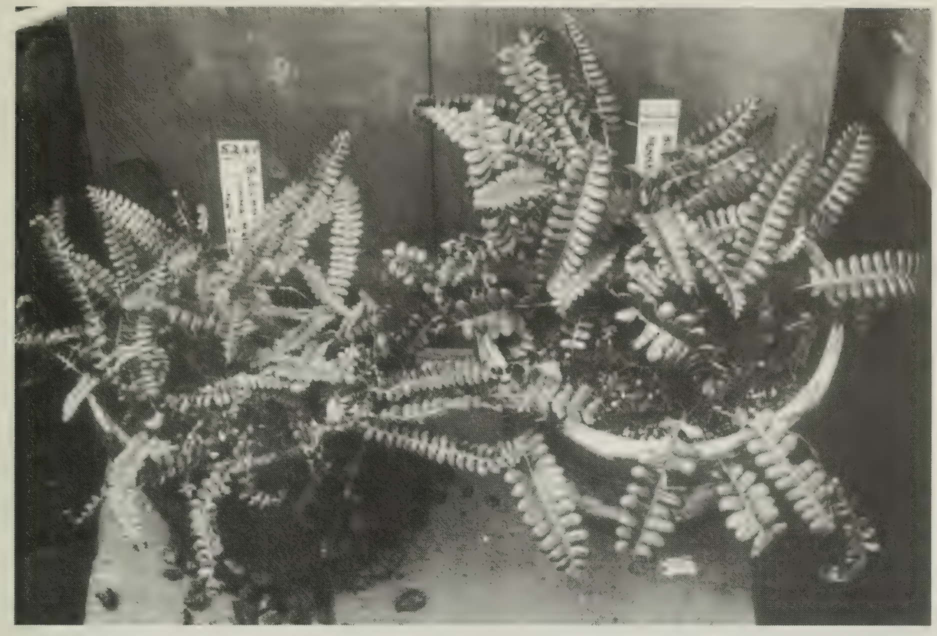

Figure 2 *Blechnum penna-marina* from New Zealand (left) and from Tristan da Cunha (right) cultivated under uniform glasshouse conditions at the University of Leeds. The New Zealand material, here defined as *B. penna-marina* subsp. *alpina*, and the Tristan material, here defined as subsp. *penna-marina*, show clear differences in frond and pinnae size and form.

Bay Co., Nelson, 2700', *R. & E.F. Melville 6032 & H. Talbot*, Jan 1962 (NSW 235321); Canterbury: Mt Wall, 3500', *J. Thompson 659*, Apr 1973 (NSW 235329); Swampy Hill Dunedin, 1500', *T.C. Chambers 33* (AK 166935).

CHATHAM ISLANDS: Ridge above Waipana Stream Pitt Island among grass in fern tree grove, *B.G. Hamlin*, 1812 (WELT P3798).

CAMPBELL ISLAND: Slopes above Venus Bay, *W.B. Brockie 2*, Jan 1947 (WELT P1339); Tucker Cove Valley, *R.L. Oliver*, Oct 1944 (WELT P8679); Garden Cove, *J.H. Sorensen*, Mar. 1947 (WELT P1337/8).

ANTIPODES ISLANDS: *T. Kirk*, Jan 1890 (WELT P4845).

AUSTRALIA: New South Wales: Dawson's Spring, Mt Kaputar National Park, *R. Coveny 8948 & S.K. Roy* (NSW); near pluviometer, Luthers Creek on Kanangra Walls road [7.5 km SSE of Jenolan Caves], *R. Coveny 9460 & P. Hind* (NSW); Cave Creek, 32 km NNE of Kiandra in Kosciusko National Park, *R. Coveny 5460* (MEL, NSW). Victoria: Scout hut, Bogong High Plains, *T.B. Muir 688* (NSW). Tasmania: 1 km W of Derwent Bridge, *R. Parsons 167/87 & J. Everett* (NSW).

MACQUARIE ISLAND: *Laird 220-224*, Nov 1948 (K); Razor Back Ridge, 500', *W. Taylor*, Mar. 51 (K).

CHILE: Prov. Magellanes 50 km SW Puerto Natales, road to Punta Arenas, *Eyerdam et al* 24182 (K); Magellanes Last Hope Inlet, foot of Mt Dorothy, 25 m, *Y. Mexia 7989*, April 1936; Prov. Llanquihne, Las Lagunillas about 10 km W of Puerto Montt in a bog, *Sparre 1858*, Jan 1947 (K) [det. as *B. penna-marina* var. *uliginosum* (Phil.) C. Chr. by Looser]; Loreto Punta Arenas, *G.M. Hall*, Jan 1909 (K).

ARGENTINA: Terr. Santa Cruz, Rio Gallegos, Estancia Stag River, *Tweedie 53*, Nov. 1957 (K); Estancia Stag River, *Tweedie 10*, Nov. 1957 (K).

FALKLAND ISLANDS: Hookers Point E of Port Stanley, *S.W. Greene 47/1*, Dec 1960 (K).
BRAZIL: Est. Sao Paulo - Campos do Jordao, *L. Lanstyack,* Apr. 1937 (K, RB 33131); Itatiaia - Planalto 2300-2400 m, *Brade 18890*, Feb. 1948 (RB 62235) [a more robust specimen approaching subsp. *boliviana*]; Prov. of Rio de Janeiro, *Glaziou 7324*, 9059 (K).

Blechnum penna-marina (Poiret) Kuhn subsp. **boliviana** (Rosenstock) T.C. Chambers & P.A. Farrant comb. nov.

B. penna-marina var. *boliviana* Ros. in Fedde, *Repertorium novarum specierum regni vegetabilis* 9: 60 (1913), T: Unduavi, *Dr Buchtien*; holo: BM; iso: P.

Lomaria sellowiana Presl, *Tent. pterid.* 142 (1836) [*L. sellowiana* Pr., Herb. Bras. Reg. Berol. n. 100], *nomen nudum,* T: Brazil, *Sellow*; holo: location unknown; lecto (here chosen): K (specimen on mixed sheet); isolecto: P (photo BM ex Morton 43900).

Illustration: **Figure 1g-k.**

Rhizome short or long creeping. *Fronds* 16-73 cm long and 1.8-3.0 cm wide, living plants dark green. *Stipes* 3.3-31 cm, reddish or dark brown. *Lamina* linear-lanceolate, pinnatisect-pinnate, 23-64 pairs pinnae. *Sterile pinnae* oblong-obtuse or somewhat triangular, 0.8-1.8 cm long and 3.0-6.5 mm wide, papery to coriaceous, adnate with broad bases, margins entire or slightly crenate, often reflexed. *Spores* 37.0 x 27.3 µm (n = 1 specimen, spores viewed with SEM), perine scabrate to microrugulate, exine scabrate.

Cytology: not known.

Distribution and habitat: Occurs in Bolivia at high altitudes and is also present in southern Brazil.

Selected specimens:
BOLIVIA: Unduavi Nordjungas 3200 m, *O. Buchtien 4*, Feb 1914 (BM, NSW 235305).
BRAZIL: S. Catharina, Taimbesinho-Ararangua, 900 m, *Reitz 2042* (BM); Compos do Jordan, *Leite 3884*, Dec 1845 (BM); Taimbesinho, S. Catharina, *Reitz 1476*, Feb 1946 (BM).

Notes: It seems characteristic of Brazilian and Bolivian material that the widest portion of the vegetative frond is about one-third distance from the distal end of the lamina region with the tapering much more gradual towards the stipe end.

Blechnum penna-marina subsp. **microphyllum** (Goldmann) T.C. Chambers & P.A. Farrant
= B. microphyllum (Goldm.) Morton

Lomaria microphylla Goldmann, *Nova Acta Acad. Caes. Leop. - Carol. German. Nat. Cur.*, 16 Suppl. 1: 460 (1843); *Blechnum microphyllum* (Goldm.) Morton, *Amer. Fern J.* 60: 103 (1970), T: Chile, *Meyen*; iso (possibly holo): B (Morton photograph 10180).

L. australis Kunze, *Linnaea* 9: 57 (1834), T: "Crescit in Chil. austr. Andibus ad Antuco, lect. 1828," *Poeppig*; holo: destroyed in Leipzig during the war; iso = lecto (Morton, *Amer. Fern J.* 60: 104, 1970) "*Lomaria australis* mihi": B (Morton photograph 10182). Non *B. australe* L. (1767).

L. gayana Rémy & Fée in Gay, *Fl. chil.*, 6: 481 (1853); *Blechnum gayanum* (Rémy & Fée) Sturm, *Enumeratio plantarum vascularium cryptogamicarum chilensium* 24 (1858), T: Chile, "Cordilleras de Talcaregue, provincia de Colchagua," *Gay*, Feb. 1831; holo: *n.v.*; iso: BM.

L. germainii Hook., *Sp. fil.* 3: 32, t. 152 (1860); *Spicanta germainii* O. Ktze *Revis. gen. pl.* 1: 821 (1891); *Blechnum germainii* (Hook.) Christ, *Bull. Herb. Boissier II,* 2: 554 (1902); *B. gayanum* (Rémy & Fée) Sturm forma *germainii* (Hooker) Looser, *Apartado de la "Revista*

Universitaria" 43, fig. 14 (1958), T: Chile, "cerro de la Campana de Quillota", *Th. Germain*" 1856-57; lecto (chosen by Looser): K (lower specimen; upper specimen is *B. penna-marina* subsp. *alpina*).

L. andicola, Philippi, *Anales Univ. Chile* 94, 353 (1896); *Blechnum andicola* (Phil.) C. Chr., *Index filic.* 150 (1906), T: Philippi & Borchers, Exp. to Atacama, Chile, 1885; holo: *n.v.*; iso: *Philippi 20/1*, Banos de Chillan (1883): BM.

We have not seen any type specimens for the following names, but from their descriptions they can most probably be referred to *Blechnum microphyllum*: *L.*? spec. sterilis Kunze, *Linnaea* 9: 58 (1834); *L. araucana* Philippi, *Anales Univ. Chile* 94, 354 (1896), *Blechnum araucana* (Phil.) C. Chr., T: "Prope La Cueva in Araucania legit orn. *C. Rahmer* Januar. 1887".

The following unpublished names can also be referred to *Blechnum microphyllum*: *L. crenulata* Moore, cultivated by Veitch, ex Chile, Hort. Veitch 1862 ex Herb. Thomas Moore, *Pearce 98*, 1884 (K, 2 specimens); *Blechnum nivale* Reimers, Chilean specimens collected by *Werdermann* and distributed under this name (Morton, *Amer. Fern J.* 60: 105, 1970); *Blechnum goldmanii*, Chile, Prov. de Colchaqua, in Cordill. de Caouquenes, Jan. 1831, *Gay 1828-31* (P, several specimens).

L. poeppigianum Sturm, *Enumeratio plantarum vascularium cryptogamicarum chilensium* 26 (1858), T: Chile "(Besser n. 170) in Chil. austr. Andibus ad Antuco (Poeppig)", is probably referable to *Blechnum microphyllum* because Sturm listed *L. australis* Kunze and *L. microphylla* Goldmann as synonyms; however, Sturm did not give a description and we have not seen any type specimens.

Illustrations: **Figure 1a-c**; Fée (1854-57) [as *L. gayana*], Hooker (1860) [*L. germainii*, reproduced by Looser (1958) as *B. gayanum* forma *germainii*].

Rhizome creeping to suberect, dark brown or black, bases of old stipes persistent, frequently 2-4 cm long. *Fronds* small, 7-28 cm tall and to 3.4 cm wide; fertile fronds usually half as long again as the sterile fronds. *Stipes* short, 4-7 cm, one-third to one-fifth the length of the lamina region, (fertile fronds with a longer stipe, up to half the length of the lamina) stramineous above, dark at the base, upper stipe with a few smaller bullate scales as long as wide. *Lamina* lanceolate, pinnate, 8-33 pairs of pinnae. *Sterile pinnae* oblong, acuminate, obtuse or minutely mucronate, 1.4-1.7 cm long and 0.3-0.4 cm wide, adnate but constricted close to the rhachis, varying from papery to thick and coriaceous, frequently overlapping in their insertion on the rhachis, margins usually distinctly crenate (though varying from entire or minutely undulate to distinctly toothed), especially the acropetal margin and sometimes more so in distal pinnae, the crenations associated with the glands at the vein endings on the upper margins, margins not usually reflexed. *Fertile pinnae* closely inserted, the longest near the mid region, the distal broader and more crowded. *Spores* 30.8 x 23.0 µm (n = 5 specimens, spores viewed with SEM), perine scabrate to microvermiculate or microverrucate, exine smooth, granulate or scabrate.

Distribution and habitat: Known as yet only from one mountainous part of Chile, close to the border with Argentina, where it grows in rock fissures at high altitude.
Selected specimens:
CHILE: Prov. Nuble Baños de Chilln, Aguas Calientes 2200 m, *Werdermann 1288*, Mar. 1927, (E, K); Baños de Chilln, Chile-Argentine frontier, *H.J. Elwes*, Dec. 1902 (K); Baños de Chilln, *T. King,* 1900 (E); Banos de Chilln, *Philippi & Borchers*, Jan. 1883 (BM); Chile, *Cl. Gay* (RB 144545).

Notes: Blechnum penna-marina subsp. *microphyllum* is recognised by its crenate margins and pinnae that are constricted close to the rhachis.

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THE MICROSPORES OF *ISOETES COROMANDELINA* (ISOETACEAE : PTERIDOPHYTA)

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Keywords: Microspores, *Isoetes coromandealina*, perispore, India.

ABSTRACT

The study of microspores of different populations of *I.coromandelina* has revealed that microspores may be monolete or trilete exhibiting considerable variation in size and shape within one and the same sporangium. The perispore may be loose or closely appressed to the exospore. Their surface ornamentation is invariably echinate but the length and the concentration of the spines and their arrangement may differ in different populations.

INTRODUCTION

Pfeiffer (1922) and Knox (1950) described the microspores of *Isoetes coromandelina* L. (f.) under Light Microscope (LM) and reported respectively that their surface was smooth or rugose to papillate. Lately Marsden (1976) has described the microspores of *I. coromandelina* sub. sp. coromandelina (from Khandala, India) under Scanning Electron Microscope (SEM) and found them to be covered with "some-what rough conical spines". The present work was undertaken to find out if the observations of the three previous authors represent a range of variation in sporoderm ornamentation in different populations of the species or if they are due the use of different microscopic techniques.

MATERIAL AND METHODS

Plants of *I. coromandelina* were collected between 1985 to 1992 from a number of localities in India, e.g. Bamhani, Bhatgaon, Bilaigarha, Karipat and Khapridih in Raipur and Mutkuli in Hoshangabad, Madhya Pradesh; Pratappur in Allahabad, Uttar Pradesh and Quilon, Kerala. The spores were acetolysed according to the method of Erdtman (1952) and their size was measured before acetolysis. LM photomicrographs have been taken with a Nikon HFX-IIA, optiphot in transmitted light and SEM photomicrographs of dried untreated microspores after coating them with gold palladium with a JEOL SEM 35 C model and a Cambridge SEM at the National Botanical Research Institute Lucknow and Indian Institute of Technology Kanpur respectively through the kind courtesy of their Directors and help of their S.E.M. staff. The descriptive terms used follow those of Jackson (1928) and Kremp (1965). The specimens of different populations of *I.coromandelina* from which the microspores have been prepared are deposited in Duthie Herbarium of Botany Department, Allahabad University, Allahabad.

DESCRIPTION

The microspores may be relatively larger and spheroidal or somewhat smaller and ovoidal. Both types of spores occur in the same sporangia but their relative frequency varies in different populations (see Table No.1). The microspores of Pratappur populations are almost all spheroidal. We found that the shape of microspores can generally be correlated with the length of the laesural ridge: if the microspore is ovoid it shows a long and longitudinal laesural ridge extending from one of its narrow ends to the other (Fig. 1,B) but if the microspore is spheroidal it shows a laesural ridge only in the central region of its body (Fig. 1,A,E). As a rule, the

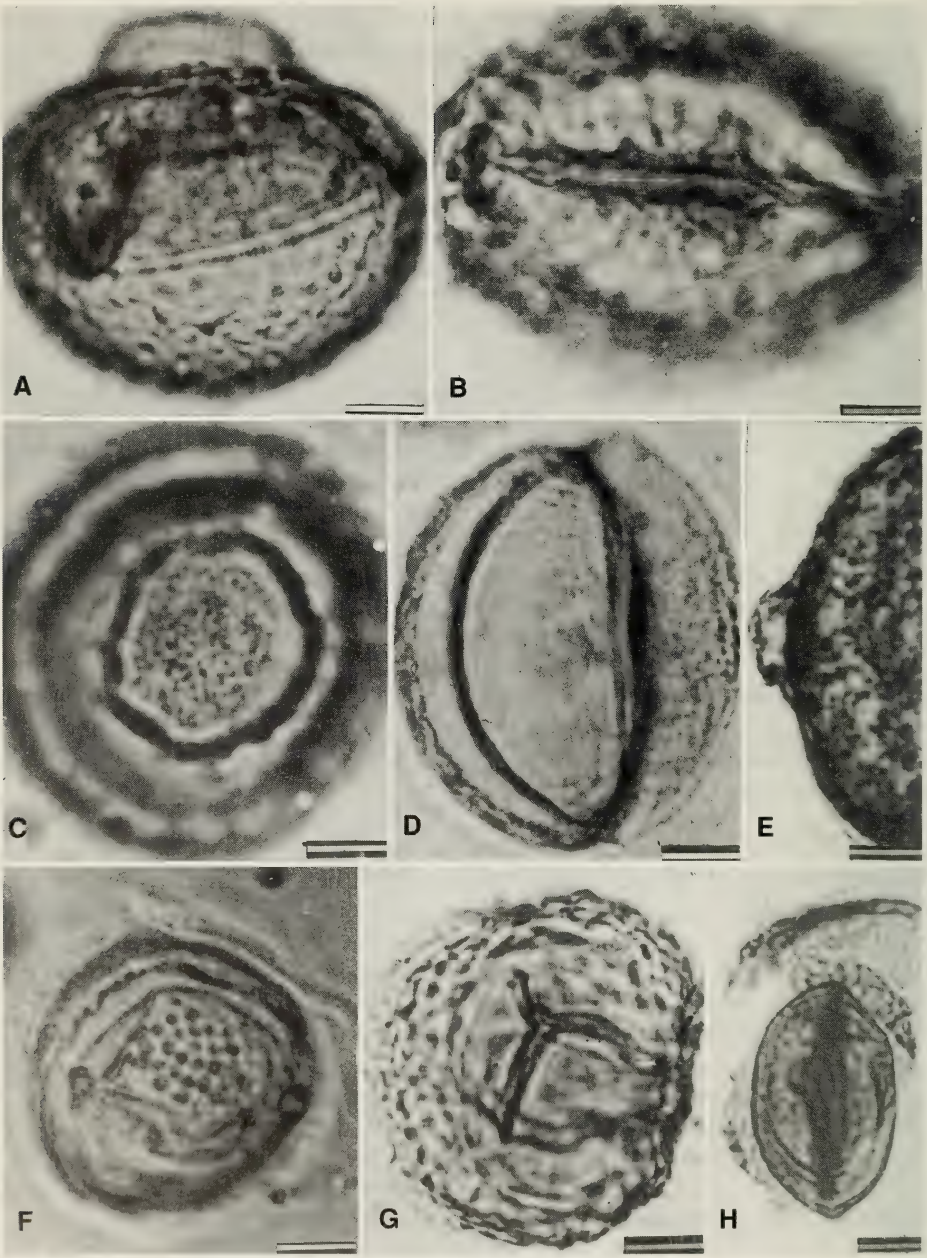

Figure 1: A-H. Photomicrographs of the microspores of *I.coromandelina*. A. (Quilon), proximal view; B. (Raipur), proximal view, C. (Quilon), F. (Matkuli), proximal views showing granular and large dark spots on mesosporium walls, respectively; D. (Matkuli), E. (Raipur), lateral views; G. (Quilon), proximal view; H. (Raipur), partly dissolved microspore showing mesosporium. Bars in A,C. = 5.50 µm, B. = 5.0 µm and D,E,F,G. = 6.5 µm, H. = 4.15 µm.

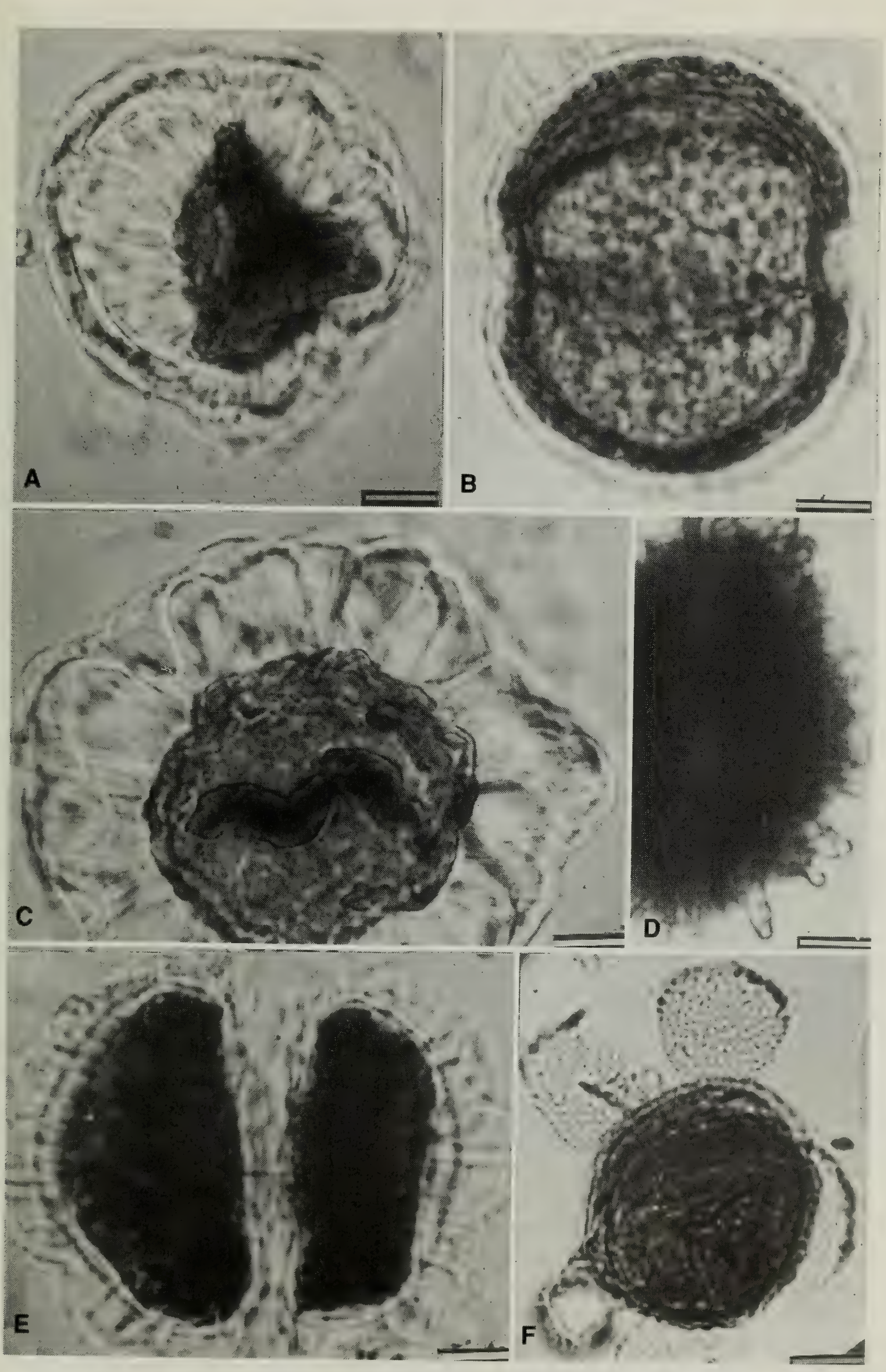

Figure 2: A-F. Photomicrographs of the microspores of *I.coromandelina*. A, C. (Khapridih), proximal views showing wide perispore; B,E. (Matkuli), joined microspores; D. (Matkuli), a portion of margin of microspore showing spines; F. (Raipur), over macerated microspore showing separated perispore. Bars in A, C. = 7.5 μm; B,D,E. = 6.50 μm; F. = 11.10 μm.

microspores are monolete but a few trilete ones are also found (Fig. 1,G). The laesural ridge shows a lip which is prominently raised-like a flange above the body of the microspores (Fig. 1,A,D). The diameter of the microspores and the length and height of the lip forming a flange are often variable in some of the populations or even within the same sporangium (Fig. 1, A,B,D,E). In most of the observed populations, abortive microspores are present in large numbers but a few populations showed a small number of such spores. After acetolysis the microspore wall shows three layers, viz., perispore, exospore and mesospore. The surface ornamentation of perispore of all populations is echinate. Unmounted dry microspores generally show very distinct spines all around the periphery of the microspores under LM (Fig. 2,D) but they become obscure after mounting in glycerine jelly and may or may not be visible. SEM photomicrographs show prominent spines all over the surface of microspores. The spines have simple, bifid, trifid or multifid apices. The spines may be sparsely distributed, or crowded or so closely crowded that their bases are coalescent (Fig. 3,A-F). In dry or unacetolysed microspores, the perispore and exospore are so closely appressed to each other that they appear like a single layer. However, on acetolysis the two layers fall apart and the perispore now appears like a border around the exospore so that one can easily separate them by prolonged acetolysis (Fig. 2,F). Unacetolysed microspores of Khapridih population are exceptional in showing a loose, irregularly shaped occasionally frilled perisporal sac around the exospore (Fig. 2,A and C). The exospore is finely pustulate and pustules may be closely crowded or widely spaced. The bases of crowded pustules may join each other to form rugulae. Inside the exospore lies the membranous mesospore which forms a roundly triangular or oval sac (Fig. 1,H). The surface of mesospore is generally smooth but sometimes finely to coarsely granular particularly in the area below the trilete (Fig. 1,C). In a single microspore, out of a very large number of specimens examined by us, we found about thirty rounded dark spots (pits) around the proximal pole occupying the interradial areas of the overlapping exospore (Fig. 1,F).

DISCUSSION

While the morphology of the megaspores in diverse species of *Isoetes* is well known that of the microspores is rather poorly described for most species, e.g., out of thirteen species of *Isoetes* described from India, details of megaspores are known for all while the microspores are described for only eight. One of the reasons for this lack of knowledge of microspores could be the usual occurrence of plants in their female or megasporangiate stage. Stages of plants having both kinds of sporangia are available only occasionally and even when they are found the microsporophylls and their sporangia being freshly formed and nearest to the apex are not usually in their mature stage. However, late in the growing season, long after the rainy season when pools are drying up, one can sometimes come across a few plants showing a good number of mature microsporophylls. In our collection from Karipat, we found a single dried up specimen of *I. coromandelina* whose sporophylls, about 25, were all microsporangiate. Obviously its megasporophylls borne around these had decayed out and no trace of them was visible. Abraham & Ninan (1958) too had reported similar microsporangiate plants from Chakkai in Trivandrum (now Thiruvananthapuram), Kerala. Dark spots in the area around the proximal pole (just below the trilete) are described here for the first time in the mesospore of a microspore of a living plant (*I. coromandelina*) although similar dark spots have been described earlier in some fossil spores. They were first found in some trilete megaspores by Høeg, Bose & Manum, (1955) and later by Pant & Srivastava (1961,1962) Similar spots have also been found in some fossil miospores by Staplin (1960); Stover (1962); Pant & Srivastava (1965) and others. Sections of the mesosporium cut by Hoeg, Bose & Manum (1955) showed that the spots were of the nature of pits. Traverse (1988) on the other hand called them

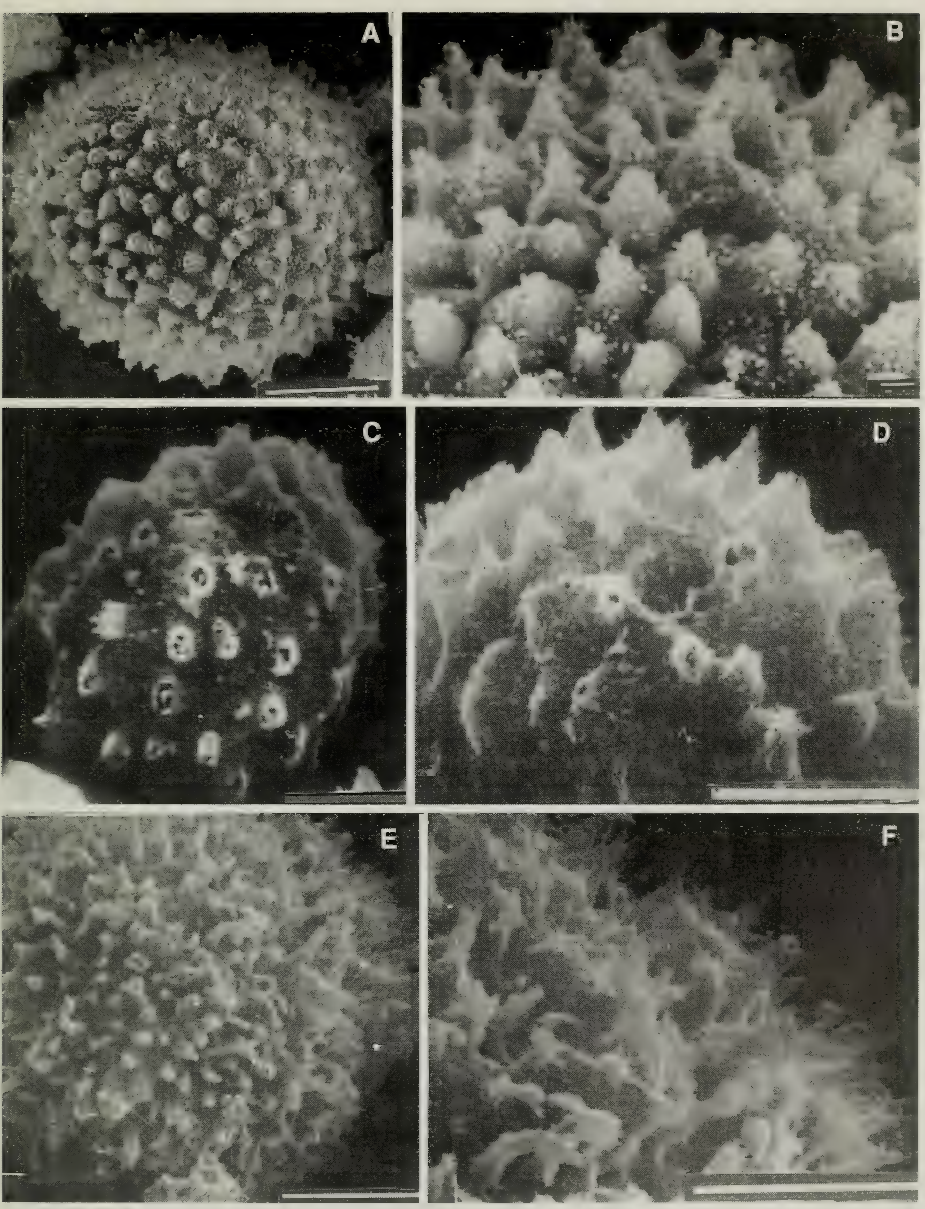

Figure 3: A - F. SEM photomicrographs of the microspores of *I.coromandelina*. A,B. (Raipur), C, D. (Matkuli) and E, F. (Pratappur), showing surface spines. All bars = 10 µm.

Table 1: Showing size of microspores of *I. coromandelina* of different populations and their statistical analysis

	Large spherical spores					Smaller bilateral spores									
	Diameter					Length					Breadth				
Populations	Range		Statistical analysis			Range		Statistical analysis			Range		Statistical analysis		
	Min	Max	Mean	S.D.	C.V.	Min.	Max.	Mean	S.D.	C.V.	Min.	Max	Mean	S.D.	C.V.
	µm.	µm.	µm.		%	µm.	µm.	µm.		%	µm.	µm.	µm.		%
Bamhani	21.0	43.0	31.2	6.0	19.3	–	–	–	–	–	–	–	–	–	–
Bhatgaon	25.0	47.0	37.0	6.3	17.0	13.0	38.0	29.4	7.9	26.9	10.6	30.0	20.8	5.4	25.9
Bilaigarh(a)	26.0	47.0	38.0	5.6	14.7	–	–	–	–	–	–	–	–	–	–
Bilaigarh(b)	30.0	47.0	37.0	4.0	11.0	13.0	38.0	27.0	8.0	29.8	11.0	30.0	19.4	6.4	33.5
Khapridih	21.0	90.0	56.3	15.1	26.8	–	–	–	–	–	–	–	–	–	–
Matkuli	25.0	47.0	34.3	4.3	12.7	17.0	36.5	27.0	4.7	17.3	8.0	26.0	19.4	3.1	16.2
Pratappur	17.0	43.0	32.2	5.5	17.3	–	–	–	–	–	–	–	–	–	–
Quilon	17.0	34.0	26.2	3.9	15.1	–	–	–	–	–	–	–	–	–	–

interradial thickenings or papillae. Since all previous reports of such spots are in fossils spores, their occurrence in microspores of a living plant could have enabled us to confirm their true nature but for the present we are unable to do so because in spite of laborious search we were unable to locate even a second spore with a spotted mesosporium.

Kott & Britton (1983) have found a correlation between the ploidy levels of the plants of a population and the mean sizes of megaspores and microspores where the diploids show the smallest mean sizes of these entities. In the presently discussed populations the mean diameters of the microspores ranges from 31.2 μm to 38.0 μm except the diploid ($2n = 22+1$) Quilon plants where the mean diameter is remarkably small (26.2 μm) seemingly agree with the observations of Kott & Britton (1983).It must , however, be mentioned that the smallest mean size of microspores in diploid Quilon population is not reflected in the mean size of their megaspores. Thus the differences in the mean sizes of the microspores may be due to different ploidy levels. Presently, however, it is difficult to correlate the mean size of microspores of other populations with different ploidy levels, although the range of the mean sizes of microspores indicates that all other populations except the plants from Quilon may be triploid or tetraploid. The higher score of CV %, indicating the higher variation in the spore sizes, may be the reflection of abnormal meiosis which is a common feature of Indian populations of different species of the genus *Isoetes*.

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NEW POPULATIONS OF *PSILOTUM NUDUM* IN SW EUROPE (PSILOTACEAE: PTERIDOPHYTA)

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Key words: *Psilotum nudum*, Iberian Peninsula.

ABSTRACT

New populations of *Psilotum nudum* are located in the SW of the Iberian Peninsula. They are believed to be ecological forms rather than a distinct variety.

INTRODUCTION

Psilotum nudum (L.) Beauv. is a pteridophyte amply distributed in the tropics (Tryon & Tryon, 1982), although it occurs as a relic in some extratropical areas (Benl, 1978). One of these areas is the Aljibe mountains in the SW of Spain, where Molesworth Allen (1966a) found it for the first time near Los Barrios (Cádiz). Since then, other authors have collected it in the same locality and, made reference to some ecological data (Galiano & Silvestre, 1974; Castroviejo in Castroviejo & al., 1986; Burges in Tutin & al., 1992).

In this paper, we describe new populations of *Psilotum nudum* in the Iberian Peninsula and we comment on its distribution, ecology and systematics.

MATERIAL AND METHODS

In studying the flora of the SW of the Iberian Peninsula we have discovered 12 new areas with populations of *Psilotum nudum* (Fig. 1.) at Jimena de la Frontera in Cadiz. The populations had between 2 and 40 plants.

To study the variability of spanish material we have also investigated, additional herbarium material from: Ascension Island, Brazil, Cape Verde Island, Dominican Republic, Ecuador, Equatorial Guinea, Gabon, Guatemala, Mauritius, Mexico, Paraguay, Peru, Senegal, South Africa, Tanzania, Uganda, United Kingdom, Zaire.

DISCUSSION AND RESULTS

Ecology: The *Psilotum nudum* localities from the SW of the Iberian Peninsula are relics of the Tertiary (Pichi Sermolli & al., 1988) and support the other evidence for the existence of tropical vegetation in SW Spain during this period (Quézel, 1978), and the idea that the Quaternary glaciations had little effect in this territory (López González, 1982).

The species belongs to an epiphytic community in the Aljibe mountains (Fig. 2C) where tropical and macaronesic elements exist (Pichi Sermolli, 1979; Díez Garretas & Salvo, 1981; Nooteboom, 1994) such as *Cheilanthes guanchica* Bolle, *Davallia canariensis* (L.) Sm. and *Polypodium macaronesicum* Bobrov, atlantic-mediterranean (Galán de Mera, 1993), as *Asplenium billotii* F. Schultz, *Polypodium cambricum* subsp. *serrulatum* (Schultz ex Arcangeli) Pichi Sermolli, and a few endemisms of SW Iberian Peninsula as *Sedum hirsutum* subsp. *winkleri* (Willk.) Galán de Mera and *Cytisus tribracteolatus* Webb.

In the whole distribution area its behaviour is as a lithophyte or epiphyte (Salvo Tierra, 1982; Tryon & Tryon, 1982). In the SW of the Iberian Peninsula it grows in fissures in the Aljibe sandstone rocks (Chauve, 1968) which are S-SE-E facing. The first populations discovered by

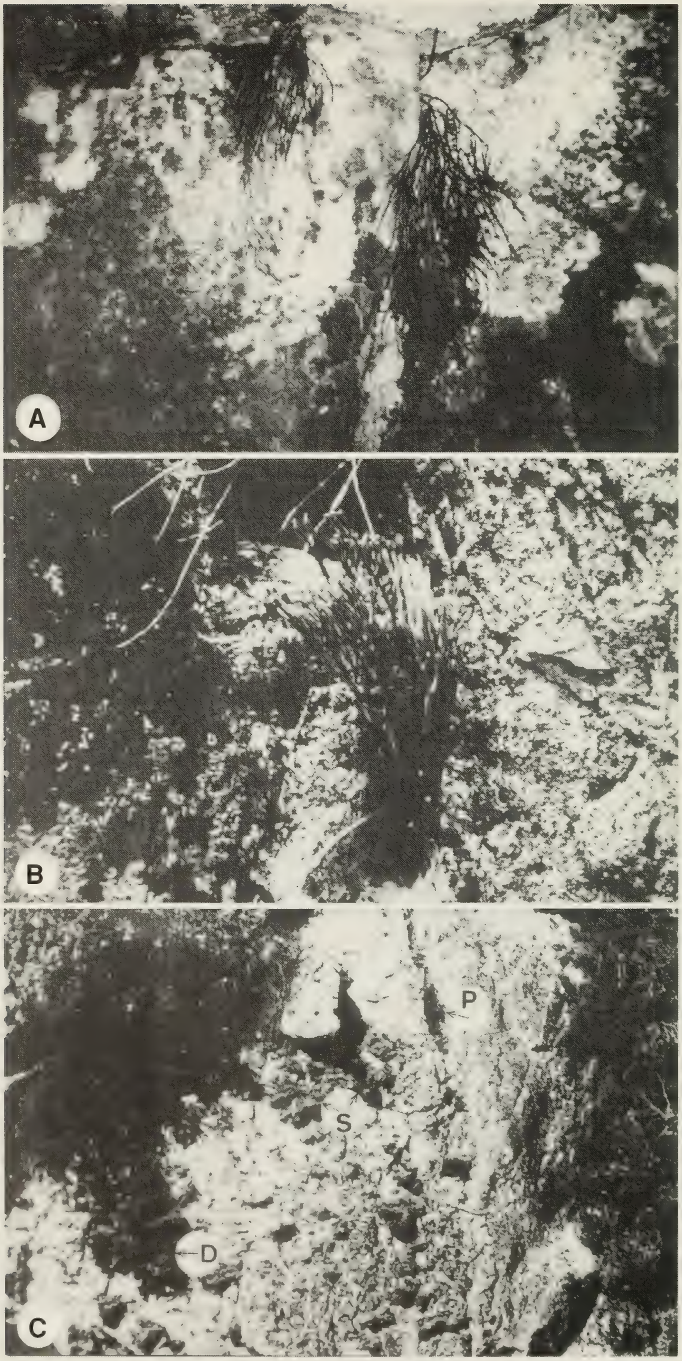

Figure 2.
Habitat and morphology of *Psilotum nudum* in SW Iberian Peninsula: A, and B. Sporophytes of two different populations; C. Communities fixed on rocks with *Psilotum nudum* (P= *Psilotum nudum*, S= *Sedum hirsutum* ssp. *winkleri*, D= *Davallia canariensis*). (Photo: A. Galán de Mera and E. de Castro)

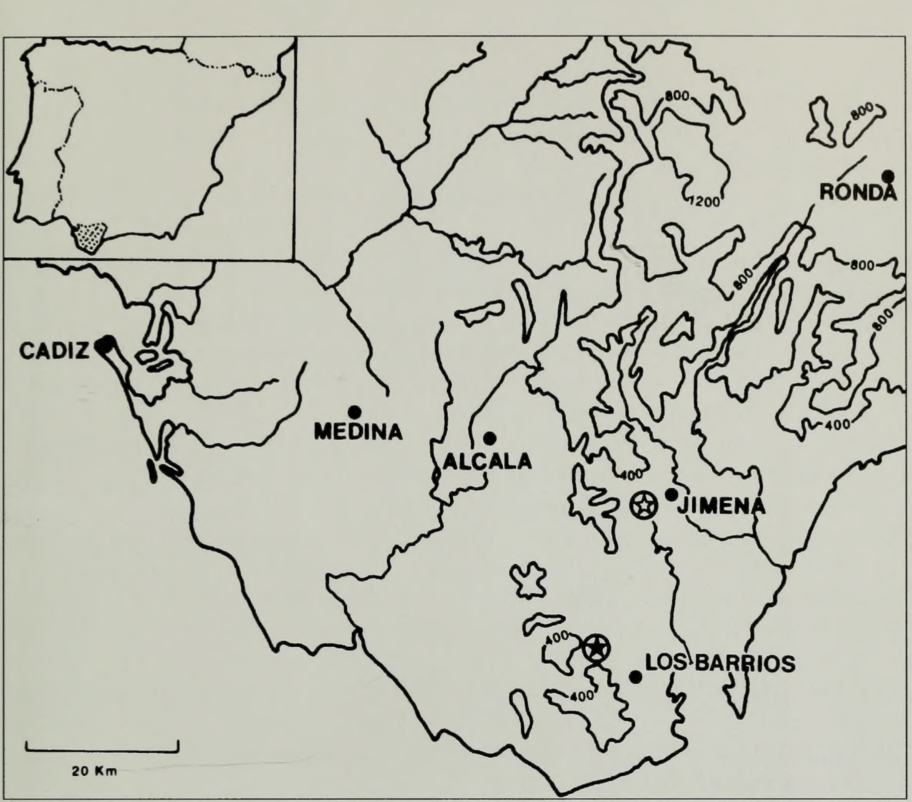

Figure 1. Distribution of *Psilotum nudum* in SW Iberian Peninsula: Los Barrios (Cádiz) locality; the new locality in Jimena de la Frontera (Cádiz).

Molesworth Allen grow at 170 m above sea level, while the new populations at Jimena de la Frontera grow between 90 and 160 m. This shows that *Psilotum nudum* prefers warmest exposures and induced Díez Garretas & Salvo (1981) to think it was a xerophytic plant. However, at Jimena de la Frontera it grows in rock crevices within alder forests with *Rhododendron ponticum* L. where conditions are very humid. This supports the idea of Molesworth Allen (1966b) and Salvo Tierra (1982) that the species was certainly not a xerophyte but has higrophytic tendancies.

Systematics comments: Iranzo, Prada & Salvo (in Salvo 1982) described the Spanish specimens as a new variety, *P. nudum* var. *molesworthae,* adding it to the four taxa recognised by Reed (1966): *P. complanatum* Sw., *P. flaccidum* Wall., *P. nudum* (L.) Beauv. and *P. nudum* var. *fallacinum* Domin. This variety was based and characterized by shorter and thicker stems than the type variety (Salvo & Cabezudo, 1984; Iranzo, Leal & Salvo, 1987; Cabezudo & Salvo in Valdés & al., 1987). However, in comparing the Iberian specimens with herbarium sheets of tropical areas of the world and descriptions within some floras (Burges in Tutin & al., 1992; Thieret, 1993; Tryon & Stolze, 1994) we see no reason to separate them in this way. Instead we suggest that the plants are merely smaller ecological forms (10-40 cm). The plants only dichotomise in their apical portions with shorter and thicker branches and stem angles. All of these characters could be induced in sunny exposures (Fig. 2B).

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